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A TREATISE

ON

ARCHITECTURE AND BUILDING CONSTRUCTION

PREPARED FOR STUDENTS OF
THE INTERNATIONAL CORRESPONDENCE SCHOOLS
SCRANTON, PA.

Volume V

HISTORY OF ARCHITECTURE
ARCHITECTURAL DESIGN
SPECIFICATIONS
BUILDING SUPERINTENDENCE
CONTRACTS AND PERMITS

WITH PRACTICAL QUESTIONS AND EXAMPLES

First Edition

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HISTORY OF ARCHITECTURE.

ANCIENT ARCHITECTURE.

INTRODUCTION.

1. Architecture had its origin in the efforts of man to provide for himself a means of protection from the inclemency of the seasons. At this period of the world's history, mankind was divided into but three general classes: hunters, shepherds, and agriculturists. The hunters dwelt mostly in rock clefts, or caves, while the shepherd pitched his tent wherever night overtook him in his wanderings with his flock; but the agriculturist became a permanent resident where he tilled his land, sowed his seed, and gathered his crops. Hence, we find different forms of habitations for different classes of people, which forms again vary in different climates and localities. In the agriculturists we find the nucleus of a community, and to this class we must look for the founders of a city and the constructors of permanent dwellings, of tombs and temples, and of other architectural edifices, which serve as monuments of instruction to future generations.

But *construction alone* is not *architecture*, for it may be found among the most uncivilized people; only when it is governed by systematic laws of proportion, which are based

upon a refined conception of what is most suitable for the purpose, can construction be classed as a *fine art*. It is for this reason we find no architectural advancement in a nation until its condition betokens culture, wealth, and prosperity.

Buildings vary architecturally, according to the purpose for which they are erected, the locality in which they are built, and the historical period in which they are designed. The first two conditions will influence the *character* of the building, while the last will very largely determine its *style*.

A building is said to have *character* when its form and proportions express the purpose for which it is intended. Its *style* will depend largely upon the method of spanning its openings, such as doors and windows (whether with lintels, after the manner of the Egyptians and Greeks, or with arches according to the Roman custom), and also upon the formation of its roof. All architectural styles are based upon one or more of three general principles of construction: the **lintel**; the **arch**, or **vault**; and the **truss**. The ornamentation of a building is governed by the purpose for which the building is intended, the period in which it is built, and the character of the people by whom it is erected. We may say, therefore, that *the history of the architecture of a country is a history of the manners, customs, and temperament of its people*.

As tombs and temples form the principal structures from which we study the architecture of the ancients, one can readily see that *religion* is a most important factor in the development of architectural history. The civilization of Egypt was very different from that of Greece, but each possessed a polytheistic form of religion, and we find a great similarity in the arrangement of their temples; but owing to the difference between their conceptions of the immortality of the soul, we find a well defined distinction in the arrangements of their tombs and the methods of disposing of their dead.

With similar religious faiths we find similar systems of architectural design, and with dissimilar customs and habits we find a corresponding variation in some branch or detail of

architectural arrangement peculiar to the customs of each individual people.

The dawn of Christianity was the advent of an entirely new style of architecture, and the division of the Church at the time of the Reformation was the signal for the alteration of this new style and the attempt to return to the old classic forms.

2. In the following pages on the styles and methods of different countries, observe how the *locality*, *climate*, and *temperament* of each people affected the contemporaneous architecture. Observe also how the religious fervor of certain classes expressed itself in every detail of their architectural monuments, and note carefully the decline in purity of style and nobleness of character, whenever the morals of a nation became lax, and worldly pastimes superseded proper religious thought.

EGYPTIAN ARCHITECTURE.

3. For the beginnings of architecture we turn to Egypt, the cradle of the arts and sciences, where we find a reverential nation, who, believing in the resurrection of the body, embalmed and preserved with great care the remains of its dead. Its people built the pyramids as resting places for the bodies of their kings, and hewed immense temples out of the mountain sides wherein to worship their gods, while their dwellings, built of sun-dried bricks molded with clay from the banks of the Nile, were ephemeral structures, typical of a people who attached little importance to the details of their earthly existence.

4. The *pyramids* form a distinct class by themselves, and present no points in common with any other Egyptian structures. They are of gigantic proportions and were accounted by the Greek historians the first of the "Seven Wonders of the World." The Great Pyramid of Cheops, as seen in Fig. 1, was constructed with blocks of limestone, some of whose dimensions are so great that it is a mystery at the present

day how they could have been quarried and transported with the primitive tools and machinery in use 3,000 years before the Christian era. This pyramid, about 800 feet square at the base, and 450 feet high, is *the largest structure in the world.* It is estimated that it took 100,000 men twenty years to build it, at a cost of over forty millions of dollars.

Next to the pyramids in massive grandeur comes the Great Sphinx at Gizeh. This is a statue of the Egyptian god Harmachis, carved out of solid rock, making a figure 146

FIG. 1.

feet long, 65 feet high, and 34 feet across the shoulders. The body, which has the form of a crouching lion, is now entirely buried in drifted sand, but the human head, measuring 28 feet from chin to top, and the broad massive shoulders, are still visible above the sand drifts, as shown in Fig. 1. Between the forefeet of the body is excavated a temple where the god was worshiped, and if built at the same time as the sphinx, this temple is the oldest architectural monument on record, as it antedates the pyramids over 1,000 years.

5. The most important architectural monuments of Egypt are its temples, and though they are very numerous and

differ widely in size and elaboration of plan, the general scheme of arrangement is the same in all cases, whether the example is taken from northern Egypt or southern Nubia.

The Egyptian temple consisted of a small sanctuary, or *sekos*, as it was called, which was reached through a large **hypostyle,** or covered columnar hall, generally known as the "hall of assembly." Preceding the hypostyle hall was a large open courtyard, which was surrounded by high walls and entered between two tower-like front walls, called **pylons.** Each of these parts varied in its simplicity or complexity in different structures, but they are the essential features of all Egyptian temples, and may be traced out in every temple plan, no matter what may be their change of form.

Between the years 1600 and 1100 B. C., the greatest temples were built. The Pharaohs wanted eternal dwelling places for their deities, and built their temples entirely of stone, laid up in blocks so massive and so well fitted that they have withstood the ravages of time down to the present day.

6. In Fig. 2 is shown the plan of the Ramesseum, a temple built by, and named after, Rameses, one of the kings of Egypt, who reigned about 1500 B. C. Here the sanctuary is

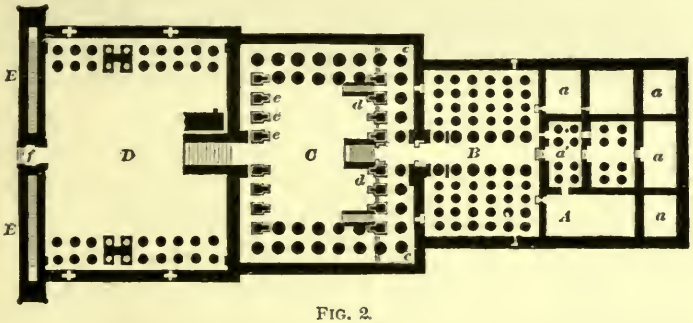

FIG. 2.

shown at *A*, surrounded by a number of smaller apartments *a*, which were used by the priests and members of the royal family, both as places for their mysterious devotions, and as royal residences; the king and his immediate relatives being

considered earthly representatives of the gods. The sanctuary contained the shrine, and was entered through either of two portals, one from the hypostyle hall *B*, and the other communicating with one of the sacred apartments *a'*.

At *B* is shown the hypostyle hall, the roof of which was supported by two sets of columns, the central ones being longer than those on each side, in order to provide a clerestory for the admission of light and air.

This is more clearly shown in Fig. 3, which is an illustra-

Fig. 3.

tion photographed from a restored model of the great hypostyle hall in the temple at Karnak. At *a* is seen the double row of long columns, which are connected longitudinally by the stone lintels *b*, in order to receive the edges of the stone slabs *c*, which form the roof over the *nave*, or central portion of the temple. On each side of these are the shorter columns *d*, which are connected transversely by the lintels *e*, and the inside row, longitudinally by the lintel *f*, to support the roof slabs *g* in the same manner as over the nave. An open space *h* is thus left to admit light to the interior of the

hall, and form a clerestory, similar to the same detail in our more modern cathedrals, of which we shall learn later on.

This system of supporting the roof is based upon the first of the three principles of construction referred to in Art. **1**; i. e., the lintel. The spacing of the supports being governed entirely by the length of lintel the builders were able to quarry, the columns are exceedingly close together, and this is the case not only in Egyptian structures, but in all architectural edifices, where the "lintel system of construction" prevails. For this reason, large apartments were never entirely roofed over in the Egyptian temples, but were open to the sky, either wholly or in part, as shown in Fig. 2 at *C*, which is the inner court of the temple, from which the hypostyle hall must be entered.

On each side of this inner court is a double row of columns supporting a roof extending from the side walls, while at the back is a single row of columns *c*, and a row of square piers *d*, which carry a portion of the roof which extends over from the hypostyle hall. Another row of square piers *e* carries the roof over the front end of this inner court, which, with the other partial coverings, surrounds the court with a narrow, projecting roof on all four sides.

Fig. 4.

The effect of this treatment must have been very imposing in itself, but, to add to the impression, colossal statues, such as shown in Fig. 4, were carved on the inside faces of the square piers, and flights of stone steps led up to a gallery at the level of the hypostyle hall, the floor of which was considerably above the level of the inner court. The outer, or entrance, court *D* was a comparatively plain enclosure, with columns on each side and a single flight of steps up to the floor of the inner court above. It was entered through a narrow portal *f* flanked on each side by the massive pylons *E*, and served merely as

an entrance court preparatory to the grandeur and solemnity of the more sacred apartments beyond.

7. The *pylons* can best be studied from the exterior, where they appear to tower up with impressive dignity as if in forbiddance to any person unqualified to enter the precincts of the gods. The entrance was approached through an avenue, sometimes over a mile in length, lined on both sides with colossal statues of sphinxes or rams, as shown in Fig. 5. The walls of the pylons were richly decorated in

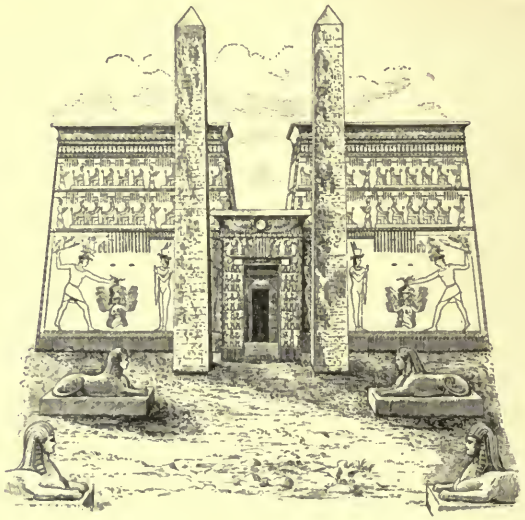

FIG. 5.

colors, with hieroglyphical figures, the outlines of which were cut into the stone in order to render the design permanent, even after the elements had destroyed the effect of the color. On the inside, the walls were similarly decorated, so that the worshiper was everywhere confronted with the mysteries in which the ancient Egyptian religion abounded. Fig. 6 shows the outer court of the temple of Isis, on the island of Phylæ, somewhat farther up the Nile than the Ramesseum. Here on the right are seen the columns which support the roof along the sides, while in the center is the entrance through which the court is reached. To the left of

this main entrance is a smaller door, used only by the priests of Isis to enter some of the secret passages leading to other parts of the temple.

At the top the walls of the pylons flared out, forming a simple concave cornice, above which iron stocks carried gleaming cressets at night and flaunting banners by day, which,

FIG. 6.

combined with the highly colored decorations on the walls, gave the building an effect of mysterious grandeur, perfectly consistent with the complex system of the ancient Egyptian belief.

8. As we progress in the study of architectural history, we will find that, in religious edifices, the aim of the designers has always been to create in the building an impression of grandeur, dignity, and awe. In Egypt the worshiper entered the temple after traversing the long avenue of sphinxes. Passing between the towering pylons, he found himself in the large outer court, which was brilliantly illuminated by the vertical rays of the tropical sun. He then

ascended the stairs to the inner court, which was smaller and partly shaded by the projecting roof. In this shade he laid his offering of fruit or grain, at the feet of one of the graven images described in Art. **6,** and then in solemn silence ascended to the gallery and entered the dimly lighted hypostyle hall to receive from the priest the acknowledgment of his offering to the gods. If he was an Egyptian of high caste, he might then proceed farther, to one of the sacred apartments beyond the hypostyle hall, or even to the sanctuary itself, but if not of royal birth his pilgrimage ended in the hypostyle hall, from whence he retraced his steps or departed from the temple through a side door provided for the purpose.

The numerous temples throughout Egypt varied in size, but the essential features remained the same, and the variation consisted principally in the addition of chapels and royal apartments around the sanctuary, while the sanctuary itself remained about the same, being one of the smallest apartments in the temple.

The great temple at Karnak, erected 1500 B. C., was 376 feet wide, 1,215 feet long, and covered over 400,000 square feet of ground—twice the area of St. Peter's Church at Rome (the largest building now existing)—but contained a sanctuary only 16 ft. $\times$ 26 ft., the area of which was only a little more than the space occupied by one of the great columns of the hypostyle hall, which were 21 feet in diameter. The Ramesseum, shown in Fig. 2, was much smaller than the temple at Karnak, being 182 feet wide and 590 feet long.

9. To the early inhabitants of Egypt, who dwelt in caves, we are indebted for the origin of the rock-cut temples. These excavated worshiping places have little architectural interest in themselves, but serve to illustrate most forcibly the temperament of this ancient Egyptian people, who toiled patiently and almost unceasingly to excavate in the mountain side a temple that should be as permanent and enduring as the mountain itself.

Fig. 7 shows the plan of a rock temple at Ipsamboul, while Fig. 8 shows its longitudinal section. The entrance is guarded by four colossal statues of King Rameses II, as shown in Fig. 9, and at *a* in Fig. 8. These statues represent the king in a sitting posture, and are 68½ feet high, and carved in the native rock of the mountain side. The general arrangement of the excavated temples is similar to that of the ones above ground. A covered vestibule hewn out of the rock forms the entrance, as shown at *a* in Fig. 7, which opens into a hall *b* that corresponds to the inner court of the open temples, as shown at *C* in Fig. 2. Beyond this is located a smaller chamber *c*, similar in position to the hypostyle hall, where columns or piers are introduced, according to

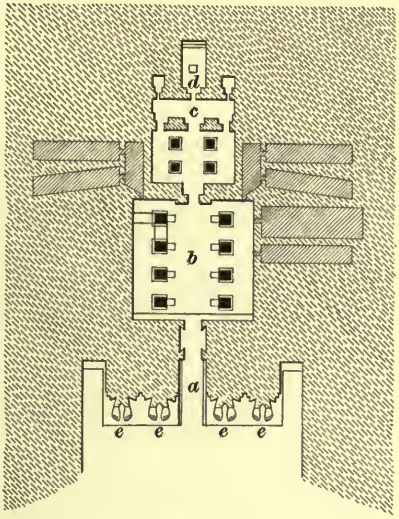

Fig. 7.

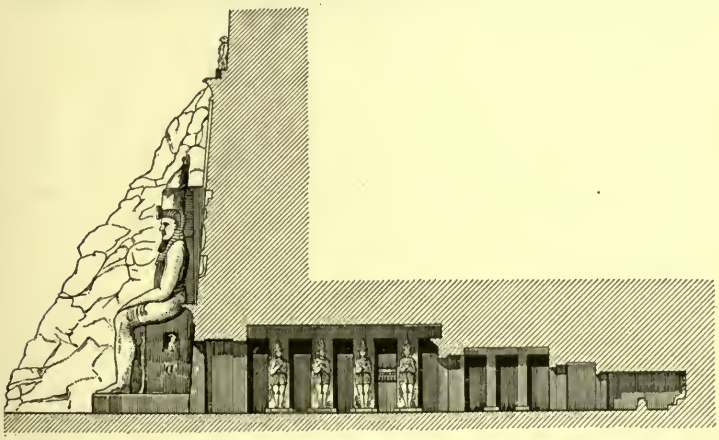

Fig. 8.

circumstances, and at *d* is excavated the sanctuary accessible to none but the priests and king. The walls, architraves, piers, and columns are always richly decorated with sculptured or painted ornament, similar to the decorations on the walls of the open temples. In these decorations the winged globe occurs very frequently, especially over entrances and on

FIG. 9.

entablatures. This consists of a globe or disk, emblematic of the sun, on each side of which is a spread wing. The winged globe is used frequently in Egyptian hieroglyphics to represent immortality or divinity, and sometimes as the emblem of sovereignty in the sense that the kings were the earthly representatives of the gods.

10. The roofs were supported on piers or columns, the earliest form being a quadrangular pillar with parallel or slightly inclined sides, without either base or capital; this form occurs in the most ancient tombs, though it may be found later in the temples at Karnak and at Medinet Abou. The sides of these square columns are often covered with

painted scenes; the front is usually sculptured, sometimes with a head, and at other times with a full-length figure of Osiris, the god, who, according to Egyptian Mythology, represented the beneficent power of nature, and was supreme judge of the dead. Fig. 4 shows one of these square columns, in the temple at Medinet Abou, and is a type of them all, though the details of the figure may vary slightly in different examples.

By cutting off the corners of these plain square pillars, we make an eight-sided column, and then cutting the eight new edges, a column with sixteen sides is obtained, as in the processional hall of the great temple at Karnak. In this same temple we find columns with thirty-two sides, the arrises, or meeting edges, of which are emphasized by making the sides slightly concave. The addition of a large square slab on the top gives us the form of column used in the facade of the tombs at Beni Hassan, erected 2000 B. C., as shown in Fig. 10, and this column is of vast importance in architectural history, as it is undoubtedly the prototype of the *Grecian Doric*, of which we shall learn more later on.

Fig. 10.

11. Subsequently the column became perfectly round, and tapered towards the top, where it spread out into an enormous bell-shaped capital (therefore called **campaniform**), carved and painted to represent the full blossom of the lotus flower, as shown at *i*, Fig. 3. The edge of the shaft at the bottom was sometimes rounded off and decorated with a pointed ornament representing the large leaves around the sprouting lotus, above which to the top of the column would be engraved hieroglyphic inscriptions or bas-reliefs, as shown in Fig. 3. The corners of the four and eight sided columns were sometimes rounded

off, while the plain sides were reeded, thus giving the appearance of a bunch of stems. These stems were finished with a clustered row of *lotus buds* under the capital, as at *j* in Fig. 3, and were ostensibly held in place by a number of bands, as at *k*. The capital was narrower at the top than at the bottom, and its surface was sometimes reeded like the shaft, or painted on a smooth surface to represent the reeds. Such columns are called **lotus-bud** columns.

Another form of column had a square cubical block for a capital, the upper portion of which was designed to represent a *naos*, or cell, similar to the sanctuary, with a miniature entrance and propylon on each side, under which were carved heads of either that of Hathor or Isis, the former the Goddess of Love, and the latter the Goddess of Fecundity and consort

FIG. 11.

to Osiris. These columns are known as **Hathor-headed** or **Isis-headed,** as the case may be, and are as shown in Fig. 11, which is a portion of the Temple of Hathor at Dendarah.

Fig. 12 shows a restoration of one of these columns, from which the details may be more clearly understood. In the architecture of Egypt, there are no established rules of proportion. The height and projection of the capital bear no fixed relation to the length or diameter of the column, as do these details in later architectural styles, and the construction being almost entirely of stone, the columns were placed very closely to receive the lintels and slabs that formed the roof.

12. The distinguishing characteristics of the Egyptian style may be summed up as follows: massive tapering walls, surmounted with a great cavetto cornice; short, thick, closely spaced columns with the lotus-flower capitals; prolific decoration in bas-relief, and hieroglyphic painting; colossal figures of human beings, sphinxes, and the obelisk. The general appearance and effect of Egyptian structures was that of solemn grandeur, which, in their temples and tombs, seems to have been pervaded with a deep sepulchral gloom, fittingly symbolizing the mystic character of the religious belief which this ancient people respected.

FIG. 12.

While the Egyptians made use of the *arch* in some of their minor constructions, it never appears as an *architectural feature* in any of their works. All openings were spanned by *lintels*, and the vaults and arches that did exist were mostly produced by *corbeling* each course of stone beyond the next one below, and not by means of **voussoirs**, as the wedge-shaped stones in the circumference of an arch are designated.

The importance of this will be better understood by the student later on, when we study the structures erected under the second principle of architectural style described in Art. **1**; i. e., the arch.

ASIATIC ARCHITECTURE.

CHALDEAN AND ASSYRIAN ARCHITECTURE.

13. Although the architecture of western Asia is of little importance so far as its direct influence on subsequent styles is concerned, a certain amount of consideration must be given it in order to preserve the thread of chronological architectural history.

The civilization of the valley of the Tigris and Euphrates

rivers was next in antiquity to that of Egypt, but was far inferior to that country in art and architecture. The subjects of the two kingdoms, Chaldea and Assyria, which ruled this valley, differed widely in character and culture, but the lack of good building material and the flatness of the country imposed on both nations similar restrictions of conception, form, and material. Not a tomb or a temple of these ancient nations stands today to enlighten us on the details of their systems of construction, but the remains of their palaces, especially those of Assyria, show a scale of magnificence that is simply astounding, though, owing to the lack of good building stone, these palaces were erected of brick, the poor quality of which prevented the builders from carrying their structures to any great height. Elevation above the level plain of the valley was, therefore, attained by first erecting immense terraces, or mounds, which were faced with stone slabs or hard burned brick, and on these mounds buildings of moderate height were erected. The absence of stone suitable for columns, and the difficulty of procuring beams of long span, made broad halls or large covered rooms practically impossible. The plans of these palaces, therefore, consisted of a series of long corridors and small cells, and no column or post was used anywhere, except occasionally as a window mullion. What these buildings lacked in durability, however, they made up in magnificence. The interior walls were wainscoted to a height of 8 or 9 feet with alabaster slabs richly carved in low relief to represent hunting scenes, battles, tribute to the kings, and glorification of the gods. Plastered walls were painted in brilliant colors, and every art known to these people was employed to make their palaces a maze of richness and architectural splendor.

The system of construction was simple. The clay walls, faced with alabaster slabs, enameled tile, or hard burned brick, were roofed over with cedar beams, or sometimes paved with tiles to form terraces. Light was admitted through small windows immediately under the roof, and certain rooms in the interior of the palace were entirely windowless. Even at the present day the inhabitants of

these districts take refuge from the torrid heat of the summer midday in windowless apartments, lighted only by lamps. The above facts are obtained more from the frescoes and wall decorations, than from any details of buildings which still remain. These decorations are of little interest to the architect, except where they do represent some ancient system of construction. Above the wainscots which line the courts and corridors, were wide friezes of enameled brick, richly ornamented with various symbolic forms, used as decorative motives. Of these the most frequent were "the sacred tree," the winged bull, and other mythological monsters, together with palmettes or fan-shaped floral designs, and the lotus blossom. The latter, which were used largely around the archivolts over the arched entrance gates, were probably derived from Egypt. The most characteristic adornment of these entrances were the "portal guardians," set into deep jambs. These were colossal monsters with human heads, and eagles' wings, and the bodies of bulls. Though of tremendous proportion, every part was minutely wrought, even to the details of the head dress, the hair, the feathers of the wings, and the anatomy, as shown in Fig. 13.

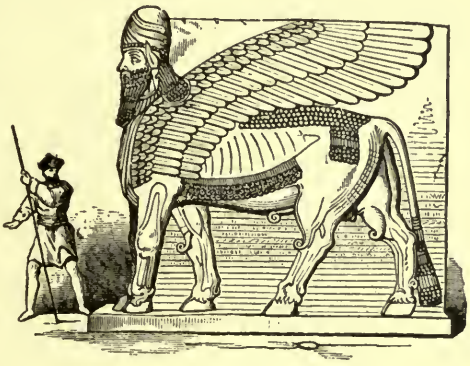

FIG. 13.

PERSIAN, LYCIAN, AND JEWISH ARCHITECTURE.

14. When the Persians conquered the Tigro-Euphrates Valley, a most important change took place in architectural history. This nation was of an entirely different race from those whose buildings we have so far considered, and consequently it stamped the architecture which it borrowed from

the Assyrians, with new forms and details, expressive of the extreme difference in the manners, customs, and temperaments of the two peoples. The Egyptians, Chaldeans, and Assyrians were of the Semitic race, supposed descendants of Shem, the eldest son of Noah, while the Persians were of the Aryan race, which was the stock from which all European people, with the exception of the Turks, have descended. The conquering nation was one of warriors, and had little artistic taste. They had overthrown the Egyptians and Assyrians, but were themselves conquered by the arts of their vanquished foes, and soon became the most luxurious of nations. The Persians possessed few original artistic forms, but coming from a part of the country that was rich in building material, they were able to combine the Egyptian system of interior columns with the elaborate decorative details so prominent in Assyrian art. Owing to the abundance of fuel in Persia, this nation used burned brick much more freely than was practical in Assyria, and their structures, thereby rendered more enduring, are sufficiently preserved to give us at the present day a very fair idea of what they were like. Stone was also used for walls and columns, and in conjunction with hard burned brick formed the jambs of doors and windows, while the archivolts or lintels and the ceiling beams were always of wood. The Persian palaces were erected on broad platforms or terraces, in the same manner as those in Assyria, but unlike the latter, they consisted of numerous detached buildings, entered through magnificent portals and gates of honor which lead to immense audience halls open on one or two sides, around which were grouped the chambers or dwelling apartments, either attached or in separate buildings. Persians, being worshipers of fire and the sun, conducted most of their devotions out of doors, and for that reason temples seem to have been of little importance, and structural tombs existed only for the reception of the royal dead.

15. Like the Egyptians, the Persians used columns as an internal feature in the construction of hypostyle halls of

great size, and externally in their porches and kiosks, or open pavilions. The great hall of Xerxes at Persepolis covers over one hundred thousand square feet, more than double the area of the hypostyle hall at Karnak, but the Persian column derived from a wooden prototype and used with a wooden lintel, permitted a much wider spacing than was possible in the stone construction of Egypt. In the hall of Xerxes, thirty-six columns were used to support the roof over the same area for which one hundred and thirty-four columns were used in the temple of Karnak. The shafts were slender and finely fluted, instead of being painted or carved, and the effect produced was totally different from that sought by the Egyptians. The capital of the column was its most striking peculiarity. It was forked at the top, each half being carved to represent the forepart of horses, bulls, or mythological monsters, as shown at *a* in Fig. 14, which were supported by a combination of vertical scrolls or volutes, as shown at *b*, resembling certain ornaments seen in Assyrian furniture. Below these, the column was carved somewhat like a double bell, as shown at *c*. This column and capital supported two pairs of architraves, or lintels, one of which rested on the heads or backs of the carved horses, as shown at *d*, while the ends of the others rested in the fork between them, as at *e*. A rich molded base supported the column, which was usually carved with leaves or flutings.

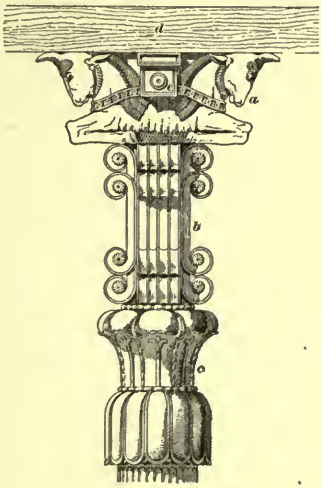

FIG. 14.

The Persian capital is unique. It has no direct prototype, yet details of many other forms may be seen in its design. In it the Egyptian capital is suggested by the bell shape at *c*, but the scroll ornament *b* is undoubtedly of Assyrian

origin, while the carved monsters at the top are of the same type as the Assyrian bull, shown in Fig. 13, but are more architectural in their position on the capital, as they form a structural part of the building and really assist in holding it up. This is very important in the study of architectural development, as it shows a tendency towards the improvement in architectural construction which culminated in Greece, where it attained perfection.

The doors and windows of the Persian palaces had banded architraves and cavetto cornices strongly suggestive of Egyptian origin. The portals were flanked, as in Assyria, by winged monsters, which, however, were built up in courses of stone, instead of being carved from single blocks like their Assyrian prototype. The alabaster wall finish of Assyria was, in Persia, replaced with plaster or enameled brick; the latter being of brilliant colors and molded into relief pictures covering large surfaces. This enameled brick is the oldest example of the skill of the Persians in a branch of ceramic art in which they have excelled the world down to the present day.

16. The architecture of the Asiatic people which served intermediate between the ancient civilizations of Egypt and Assyria and the more modern civilization of Greece, plays no important part in architectural history. The Greeks adopted many of their forms from the Phenicians and Lycians, but these forms had come originally from Egypt and Assyria. The Phenicians were traders, and in bartering for the manufactures of Egypt and Assyria, they naturally carried certain art forms which influenced subsequent architectural history. The Lycians had no architecture of their own, except a form of tomb design, which came near creating a new architectural style, and which doubtless influenced both Persia and the Ionian colonies.

17. The Hebrews borrowed from the art of every people with whom they had relations, so that we encounter in the few remains of their architecture now existing, Egyptian,

Assyrian, and Phenician forms, but nothing like a national style. The general trend of their designs was Egyptian in character, and for the description of their temples we have to depend very largely on scriptural writings. The one great achievement in Jewish architecture was the national Temple of Jehovah, represented by three successive edifices on Mt. Moriah. The first one, built by Solomon, 1012 B. C., appears, from the Biblical description, to have combined lofty entrance pylons, successive courts, and the sanctuary, or sekos, of the Egyptian temple, with cedar woodwork, repoussé metal work, and isolated brazen columns of the Phenician and Assyrian styles. This temple was nearly doubled in size by Herod in 18 B. C., who extended it southward by a terrace wall of still more colossal masonry. Some of the stones were 22 feet long, and one reached the prodigious length of 40 feet, which sizes are suggestive of Egyptian origin. The site of this temple is now occupied by the Turkish Mosque of Omar. Nothing remains of the original building except a masonry wall, now known as the "Wall of Lamentations."

GRECIAN ARCHITECTURE.

PELASGIC PERIOD.

18. Greek art marks the beginning of European civilization. This nation situated on a peninsula and cluster of islands, in the Mediterranean Sea, was engaged in an extensive trade with the nations of western Asia and northern Egypt. From each of these people the Greeks received ideas which they combined and embodied in their architectural monuments, but they effected this combination only after carefully analyzing the forms they borrowed, so as to understand their structural importance and preserve their artistic effect. The first record we have of any colonization on the shores of Greece is about the year 1800 B. C., when a tribe of savages, known as the Pelasgi, landed there from Syria or Asia Minor. The Pelasgi founded cities and remained

undisturbed in the possession of their adopted country for about three hundred years, when they were conquered by the Hellenes, a nation also of Asiatic origin, but far more civilized than the Pelasgi.

19. The few architectural monuments now standing, from which we can judge of the art and skill of this prehistoric nation, consist of massive walls, built of huge pieces of roughly hewn stone laid up together without mortar of any kind. The immense proportions of these stone blocks suggest that the method of their quarrying was derived from Egypt, while the shape of the openings in the walls produced by corbeling each successive block slightly beyond the next one below, was probably derived from some of the structures observed in Asia.

The Greek historians looked upon such achievements in construction as something beyond the power of ordinary men, and declared these walls to have been built by the *Cyclops*, a mythical tribe of giants; and to work of this character the Greek legends ascribe the name of **Cyclopean** masonry. Fig. 15 shows the general appearance of these Cyclopean walls as they are at the present day, after surviving the disintegration of centuries.

FIG. 15.

The system of construction here must still be classed with the lintel, for although the openings are closed at the top in the form of a pointed arch, that form is attained through the narrowing of the opening by the projection of each successive course of stone beyond the one next below, depending upon the preponderance of the mass over the bearing, to prevent the block from toppling over into the opening, while the top is closed by a single stone lintel or slab. This

system is somewhat more clearly shown in their tombs, the most important of which is shown in Fig. 16. This figure illustrates a section through a tomb known as the Treasury of Atreus, built at Mycenæ. The entrance *a* opens into a domed chamber, the form of which is circular in plan, while the side walls are corbeled over to make a pointed dome. At *b* is a passage through the wall to the vault *c*, which is excavated in the solid rock, similar to the rock-cut temples of Egypt. The passage *c* is corbeled over to a pointed arch similar to those in Fig. 15, and the whole exterior is covered with earth to hide all from view, except the narrow entrance *a*. These tombs were called *treasuries*, because it was a custom of the people to deposit in the vaulted chambers valuable chalices of gold, silver, or bronze, together with coins, and pottery, etc., all of which was considered to be of great importance to the dead hero in the vault, in order that he might be prepared to awake and sup with the gods.

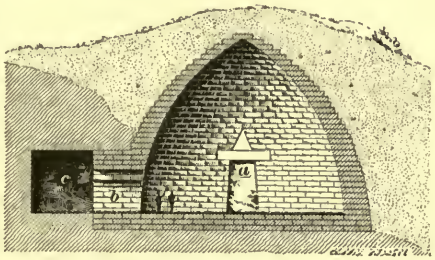

FIG. 16.

These tombs or treasuries are of importance to the architect, however, only as far as they illustrate the system of construction, and thereby preserve the thread of history, from a similar system which preceded, to an advanced system which followed.

PERICLEAN PERIOD.

20. The age of Pericles, or the period in which this greatest statesman of Greece held power, marks the dawn of architectural perfection. The architecture of the Egyptians, Assyrians, and Persians, though important in the preservation of the thread of history, has exercised but little influence upon the art of the Western nations, but the influence of this

period of Grecian art pervades all subsequent architectural history.

Greek architecture reached its full development in temples, and though we can still study the remains of theaters, circuses, market places, and tombs, it is in the Grecian temple we find that perfection of detail which has made Greek art immortal. Unlike the Egyptian temple, designed entirely for internal effect, and built with an extravagance of material, and a preponderance of strength in every detail that was awe inspiring, the Greek structure appealed far more to the admiration of the bystander on the outside than to the worshiper within. A parallelogram in plan, with columns at each end or entirely surrounding it, the Greek temple was a small structure with a simple naos, or cell, enclosed within four masonry walls.

21. The earliest temples consisted of a naos only, and were *astylar;* that is, without columns at all, except sometimes on the front, where a *pronaos*, or porch, was produced by continuing the side walls beyond the front wall of the temple, and placing the columns in *antis;* that is, between the two pilasters forming the ends of the projecting walls, as shown in Fig. 17, in which (*a*) is the plan of the temple, showing the naos, or sanctuary, at *a*, and the pronaos, or advanced porch, at *b*. In the elevation of the temple at (*b*), the pilasters on the ends of the two projecting walls are shown at *c*,

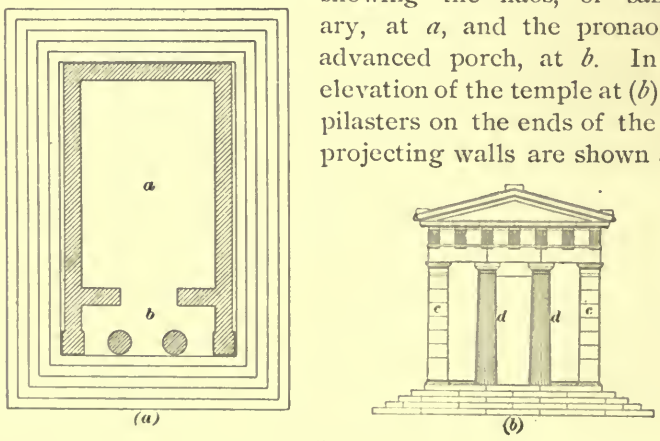

FIG. 17.

and the two columns, *in antis*, between them are shown at *d*. The next step in temple design was to advance the porch entirely beyond the front wall of the building, and support its roof with columns on three sides, converting it into a *prostyle temple*, or one with a projecting line of columns; or when both ends of the building were thus treated, it became *amphiprostyle*, i. e., prostyle at both ends, the *sides* still being astylar. Next, the columns were continued all around, enclosing the naos with a colonnade on all sides, and the temple became *peristylar*, i. e., surrounded by columns. Should there be a double row of columns all around, the temple was called *dipteral*.

22. The internal arrangement of all Greek temples was extremely simple, as shown in Fig. 18, which is the plan of the Parthenon at Athens, the most celebrated of all Greek temples. At *a* is the platform surrounding the building on which the columns rest, *b* is the pronaos, or porch, immediately in front of the entrance to the naos, or cell, *d*. At *e* is the *opisthodomus*, or treasury chamber, where the gold and silver chalices, urns, torches, and braziers, employed in various ceremonies, were stored when not in use. At *c* is the rear porch, or posticum, in front of the door of the treasury chamber. From this plan and arrangement it will be observed that the Parthenon was symmetrical; that is, its two ends were precisely alike, and also its two sides, a system of design that, with one exception, is characteristic of all Grecian temples.

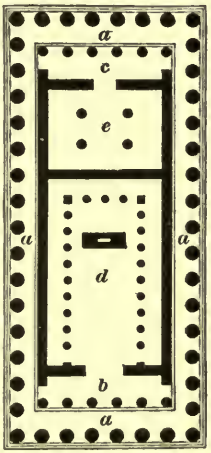

FIG. 18.

23. The architecture of the Greeks, like that of the Egyptians, was essentially a columnar system of building, though, in marked contrast to the latter, the columns were entirely on the outside of the Greek temple, while in Egypt these supports existed only within the massive walls. The

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columns in Grecian architecture were of much more slender proportions and the spaces between them were much wider than in the Egyptian structures, owing to the fact that there always existed a systematized relation between the diameter, height, and spacing of the Grecian column, and also between the mass and the mass of the superstructure, which relation varied in different designs, but was always uniform throughout the details of any single design.

24. In Grecian architecture we find three separate systems of design, each of which may be readily distinguished by the capital of its column. These systems are called **orders,** and are classified as the *Doric* order, the *Ionic* order, and the *Corinthian* order, being named after the section of the country where each system is supposed to have originated. Each of these orders consists of three principal divisions; first, the stylobate or substructure, on which the columns rest; second, the column itself standing on the stylobate, and supporting the third division, called the entablature, which is the superstructure consisting of the beams and architraves used in forming the roof. Of these three divisions, the column and entablature are again subdivided as described hereafter.

25. The **Doric order** is shown in Fig. 19, which is the front elevation of the Temple of Athena Parthenos, otherwise known as the Parthenon, a plan of which is shown in Fig. 18. The columns already referred to in the facade of the tombs at Beni Hassan, Fig. 10, and those in the southern temple at Karnak, are indisputable evidence of the source from whence the design of the Doric column was received. The Greeks took the crude article, perfected it, and made it an order of their own.

The height of the Grecian-Doric column is from four to six times the diameter, and it stands without any intermediate base, immediately on the stylobate, as shown in Fig. 19, where *a* is the stylobate under the column *b*. The column is divided into two parts, the shaft and the capital, the former being the straight portion shown at *b*, while the capital is the

cushion-shaped block *c* interposed between the shaft and entablature to receive the superimposed weight and concentrate it at the top of the column. The diameter of the shaft is less at the top than at the bottom, the diminution being effected, not in a straight line from the bottom to the top, but in a curved line which renders the face of the column slightly convex or barrel-shaped. This curved profile is called the **entasis** of the column, and its purpose is to overcome the optical illusion, which causes long straight lines to appear hollow or concave. This curvature of outline was maintained throughout the entire building, and in consequence there is not a straight line in the entire structure. The lines of the cornices, pediment, steps, and side walls, all have a slight entasis, varied in amount to suit each particular case.

The entablature is divided into three parts, the architrave *d*, the frieze *e*, and the cornice *f*. The architrave consists of the short lintels, which extended from column to column all around the building, and in the Doric order are always left to form a plain band, as shown. The frieze is formed of the band between the architrave and cornice, and is broken by the **triglyphs** *g* and the **metopes** *h*, the former representing the ends of transverse beams resting on the architrave, while the metopes are carved slabs inserted between the beams to close the open spaces. The triglyphs derive their name from the grooves, or channels, *k* cut in their faces; two being cut in the middle, and half a channel cut on each side, making in all three channels, or "glyphs," which is the meaning of the term *triglyph*.

The cornice *f* consists of the finish along the edge of the slabs, or tiles, which form the roof covering. It was usually carried up above the lowest part of the roof slope, and thereby formed a gutter, which collected the rain water and retained it until discharged through numerous gargoyles, or spouts, carved in representation of lions' heads, as shown at *l*.

26. To the Greeks we are indebted for the invention of a new architectural form, the **pediment**. This exists at the ends of the temples, and is formed by the triangle under the

roof slopes. The upper molding of the cornice was carried across the ends of the building from each side on a line with the roof slope, as at *l n* and *o n*, while the lower member was carried straight across the end of the building, as from *l* to *o*. The triangle *l o n* then forms a *pediment*, while the surface *m* which is enclosed by the moldings is called the **tympanum,** and was frequently decorated with sculptured figures as in this case, but equally often was left perfectly plain. The soffit, or under side, of the lower member of the cornice was ornamented with a number of projecting slabs representative of the ends of the rafters in the sloping roof. These slabs were called **mutules,** and are shown at *p* in Fig. 19. They were placed regularly around all four sides of the building, being centered over each triglyph and metope.

27. The Doric was the order especially loved by the Greeks, and as used in the Parthenon is as complete and as perfect an architectural feature as has ever been known in history. The design of the Parthenon is regarded with a feeling of reverence by the entire art world. It is the standard of perfection, the acme of simplicity, and the monumental witness of the reverence of the Greeks for their national deity, Athena Parthenos. In Fig. 20 is shown a view of the Parthenon, made from a restored model of the temple now in Columbia College Library, New York. This model shows the building as completed by the architect Ictinus in the year 438 B. C., while Fig. 21 shows the present condition of the structure as it stands today in ruins on the Acropolis at Athens.

28. The Greeks, like the Egyptians, used no mortar in the construction of their buildings, but carefully fitted each stone to its proper place and depended upon the force of gravity alone to render their structures stable. The columns of the Parthenon were not composed of single shafts of marble, but were built up of courses, each course being about equal in height to its diameter. These were doweled together at the center, and their bearing surfaces so nicely fitted that the joints were scarcely distinguishable, except

FIG. 20.

upon close examination. The stone blocks composing the walls of the naos were similarly doweled together, and also the members of the entablature and pediment. Each member was designed to receive only a vertical stress, due to its own gravity and that of its superimposed load; and depending thus only upon natural forces, the Greek structures were theoretically perfect in construction, and defied the disintegrating effects of time and the elements for hundreds of

FIG. 21.

years. The Parthenon stands in ruins today, as do all other ancient Greek structures, but the ruin has been caused by the vandalism of conquering nations, and not through any faulty construction by the original Greek architects. Up to the year 1687, the Parthenon stood on the Acropolis at Athens, very nearly as perfect as when completed by its architect Ictinus in 438 B. C., having resisted the elements for 2,000 years, but it was then, during the war between the Venetians and Turks, used as a storehouse for gunpowder, and an accidental explosion wrought the ruin we find there today.

29. The **Ionic order** is shown in Fig. 22, which is an elevation of the north porch of the triple temple known as the Erechtheum. The column in this order is more slender than in the Doric, being about eight or nine times its diameter in height, and instead of being divided into two parts

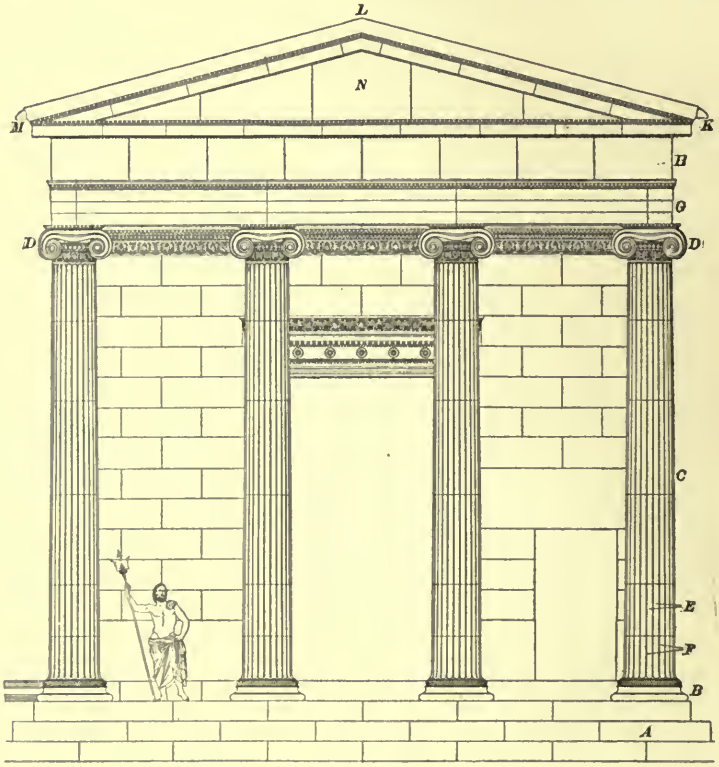


FIG. 22.

it consists of three subdivisions, the base *B*, the shaft *C*, and the capital *D*, while the stylobate *A*, on which the column stands, is practically the same as the Doric order. The base *B* is designed to spread the load transmitted by the column over a larger area than the section of the shaft represents, and is required in this order on account of the more slender proportions of the column. The shaft *C* possesses

an entasis and is grooved by twenty-four flutes *E*, which do not meet in a sharp edge or arris as in the Doric order, but are separated by a narrow fillet *F*. The capital *D* is the distinguishing characteristic of the Ionic order. Its volutes, or spirals, suggest that its design may have been influenced by Assyrian ideas, as similar volutes are seen in certain capitals used by the Persians after their conquest of Assyria, as shown in Fig. 14. The architrave *G*, unlike that detail in the Doric order, is composed of three bands, each of which projects slightly beyond the one below, and the frieze *H* is in this order a plain band unbroken by triglyphs or other details as in the previous order. The cornice is somewhat similar to the Doric in its proportions, but differs materially in its details, and the tympanum *N* under the pediment *K L M* is not ornamented with sculpture in any of the Ionic temples, remains of which are now in existence.

It will be observed that while this order is devoid of sculptured figures, many of the moldings are richly carved, while in the Doric order none of the moldings were carved, but nearly all of the plain surfaces were relieved by means of sculptured designs.

30. The Erechtheum, from which this example of the Ionic order is taken, was, as said before, a triple temple, and is the exception referred to in Art. **22,** when reference was made to the symmetrical system of design in Grecian temples. A plan of this structure is shown in Fig. 23, which exhibits the peculiarities of its outline. It combined three temples, that of the Greek god Erechtheus at *a*, and of the goddesses Pandrosus and Athena Polias at *b* and *c*, the design being intentionally unsymmetrical, not only in plan but in elevation, as the three temples were on different levels, and were varied as widely in detail as circumstances would permit. The porch of the temple of Athena Polias on the north side was on the lowest level and contained six columns, four in front, as seen in Fig. 22, and one on each side. The temple of Erechtheus on the east side contained six columns in its porch, but they were all arranged

along the front, and none were used at the sides, as shown in Figs. 23 and 24. Fig. 24 is an outline elevation of the east

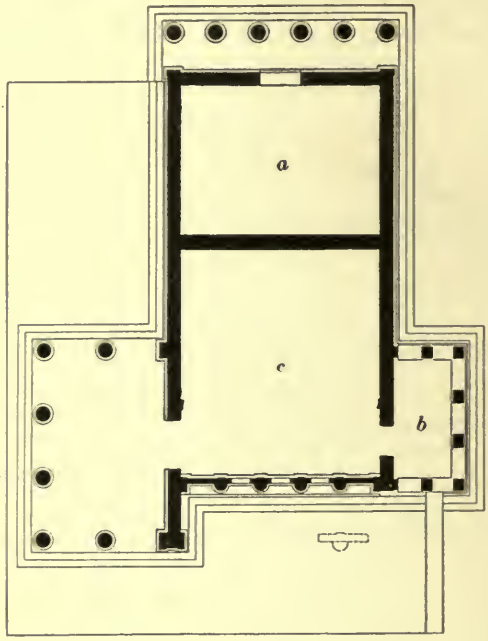


FIG. 23.

side of the temple of Erechtheus, showing the arrangement of the six columns of the porch. In the temple of Pandrosus, the roof is not supported on columns at all, but on the heads of sculptured female figures called *caryatids*. A front elevation of this last temple is shown in Fig. 25. As will be observed, the Grecian architect exerted every effort in his power to prevent this building from having the appearance of a single temple dedicated to but one god. In

FIG. 24.

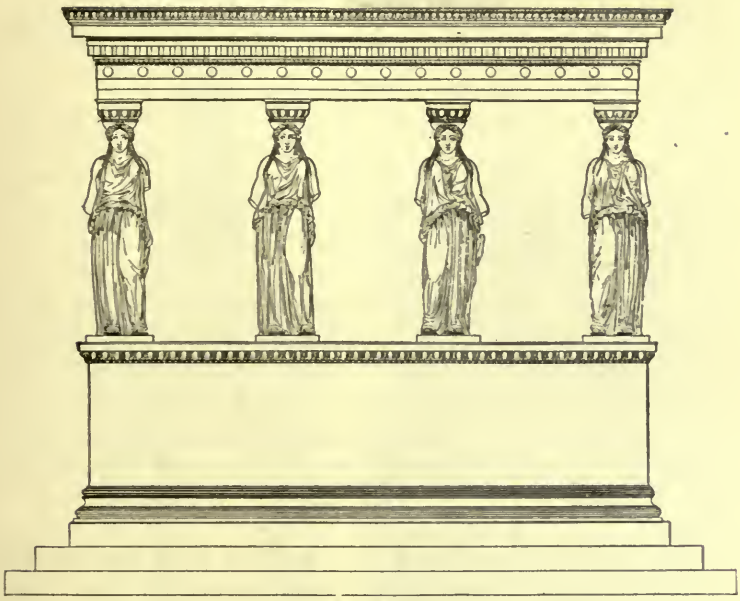


FIG. 25.

Art. **1** is explained what is meant by character in a building; surely, then, this Greek temple had character, for it shows clearly by its form and proportion that it was a triple edifice erected for the worship of three gods. Fig. 26 shows the north porch of the Erechtheum in ruins as it now exists. Many of its stones have been removed to build the walls and fortifications of the Acropolis itself, but enough still remains to impress the observer with the dignity which the complete edifice must have inspired.

FIG. 26.

31. Another Ionic structure which was demolished and built into the Acropolis walls, is the little temple of Nike Apteros, or Wingless Victory. This little edifice was rescued by architectural students, however, and rebuilt in its original position, on the right of the Propylæa stairs, as shown at *d* in Fig. 29. Fig. 27 shows the front elevation of the Temple of the Wingless Victory, as it existed after the restoration. The frieze is observed to be carved with various human figures, a condition unusual in the Grecian-Ionic buildings.

FIG. 27.

32. The Corinthian Order.—There is only one perfect example of the Corinthian order found in Greece at the present day, and this is the little structure known as the Choragic monument of Lysicrates, shown in Fig. 28. This stands on a square pedestal built to receive it, and is surmounted by a bronze tripod; but these details form no part of the order itself. The stylobate is, in this example, circular in plan, and the columns are arranged around and against a cylinder; but we will consider them and the superstructure as though they were entirely detached, as in the previous examples. The shaft of the column is grooved by twenty-four flutes separated by fillets, as in the Ionic order, but is longer in proportion to its diameter. It has also a molded base similar to the Ionic, but which is spread more on account of the smaller sectional area of the column. The capital is taller than that of either of the other orders, and is carved in representation of foliage arranged around a bell-shaped core. The entablature is similar to that division of the Ionic order, but is much richer in moldings and carved

figures. Owing to the fact that we have but one example from which to study the details of the Grecian Corinthian order, it is impossible to state exactly what the general proportions were, as this little monument, so different in its character from the other architectural monuments of Greece, may as likely have been an exception to the general rules of proportion, as in accordance with them. It is accepted, however, at the present day as the standard of Greek-Corinthian order.

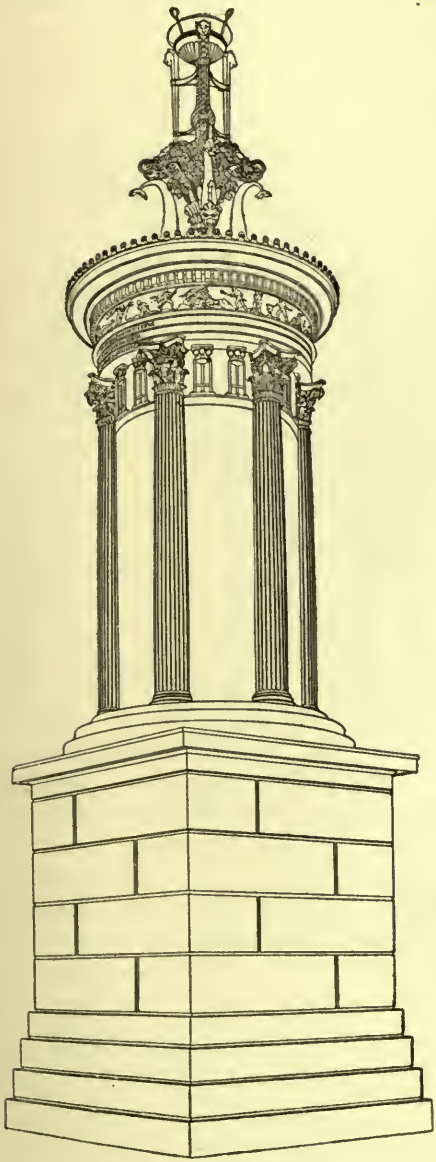


FIG. 28.

33. The *Acropolis* at Athens on which stood the Parthenon, Figs. 20 and 21, and the Erechtheum, Figs. 22 to 26, was a fortified hill surrounded by a wall which was pierced by nine gateways, the principal one of which was called the *Propylæa*, and is shown at *a* in Fig. 29. It consists of a Doric *hexaprostyle* portico (which signifies a six-columned prostyle), having the two center

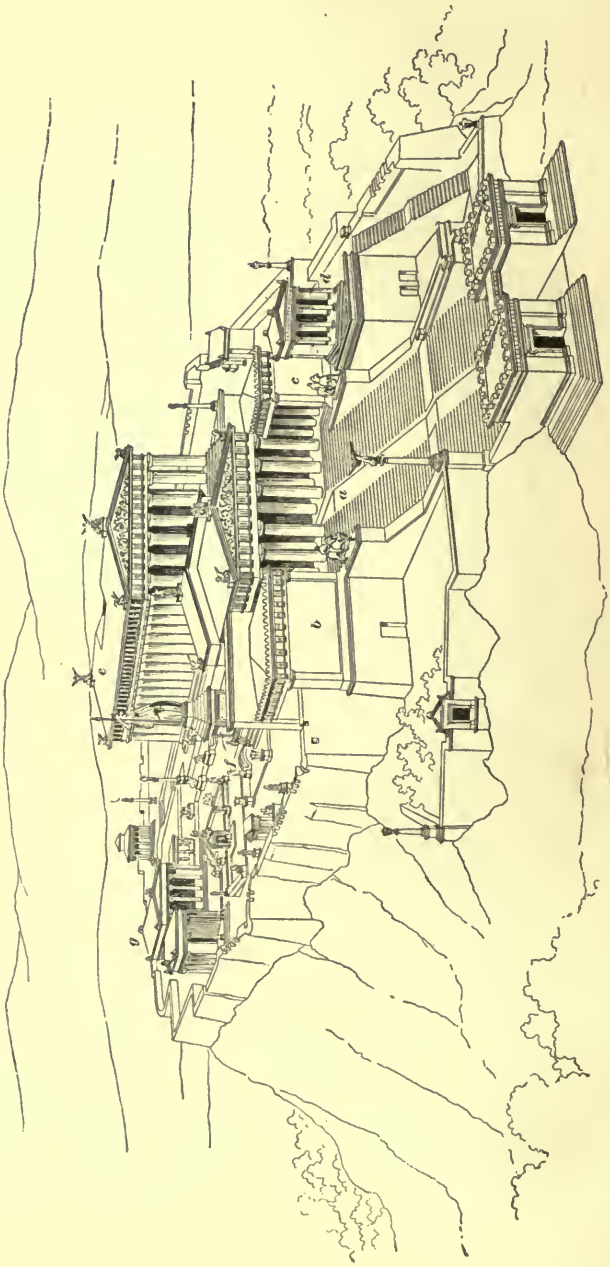


FIG. 29.

columns separated more than usual, in order to form a wider passageway for the religious processions. Beyond this is a vestibule divided into three parts by two rows of Ionic columns, each row of which forms the front of a small *tristyle*, or three-columned temple *in antis*, to the right and left of the vestibule, as shown at *b* and *c*. The whole structure, though extremely elegant and possessing many beauties, is not as good an architectural composition as the Greeks are generally capable of. The unequal spacing of the columns detracts from the harmony, and the Ionic columns in a Doric ordinance are very objectionable.

Beyond the Propylæa the summit of the hill was leveled off to form a plateau, and prominent on the south side stood the celebrated Parthenon at *e*. A monument of Athena *f*, directly in front of the center of the Propylæa, represented the goddess equipped with spear and shield in her character as defender of the nation, and to the left of this monument and northeast of the Parthenon stood the Erechtheum, as shown at *g*. Smaller temples to minor divinities, and statues of heroes and gods, were numerous along the walls of the Acropolis, and the entire plateau was laid out to make a most impressive architectural mass, worthy of the divinities to whom incense was burned on the numerous altars.

34. The *tombs* in Greece proper are of no great account architecturally, but in the Greek colonies there are several of great importance. The colossal Mausoleum at Halicarnassus, erected to Mausolus, King of Caria, was an immense Ionic structure, 140 feet high and 115 feet square at the base. The richness of its sculptures and the beauty of its proportions made it an object of great admiration among the Greeks, by whom it was classed as one of the seven wonders of the world.

35. *Greek theaters* were interesting structures, but were entirely different from the same class of building we see at the present day. They were cut out of the rock on a side hill, and arranged in the form of a semicircle, with seats in rows parallel with the circumference. The stage was built

across the center, back of which the scene was set, and the whole enclosure was covered with an awning called the **velarium,** arranged to protect the spectators from the sun. The velarium was stretched from the top of a row of columns which were the only architectural feature visible from the outside of the building.

36. Of *private houses* no remains exist, but it may be accepted as a fact, that they were very simple in plan, while the decorations and ornaments must have been chaste and refined, as every article of Greek origin, whether coin, medallion, vase, implement of war or husbandry, was a model of delicacy and refinement which no nation has ever equaled.

37. To the Greeks we owe the greater part of the beautiful and delicate details of columnar architecture. To them we are indebted for the most refined methods of obviating the defects of optical illusion. The apparent depression in the cornice, across the front of the temples, caused by the mass of material and apparent weight in the center of the pediment, was obviated by curving the cornice so that the center was highest. The steps were curved in the same way; the architrave and frieze of the Parthenon sloped about 1 part in 80 towards the center; and so it was in all the minute details of construction. The Greeks not only avoided structural weakness in design, but invented methods to overcome even the slightest appearance of such weakness.

ETRUSCAN ARCHITECTURE.

38. The Etruscans, a people of Asiatic origin, entered northern Italy about 1300 B.C. Their written language has never been translated, and their architectural monuments are so few that we have been able to learn but little of their habits and customs. But the influence of the Etruscans in the architecture of their southern neighbors, the Romans, is everywhere apparent. The walls of the Etruscan cities are

splendid examples of the Cyclopean style, but are of much more importance historically, as they contain the first examples in Europe of the **voussoired arch.** As has already been mentioned, there are examples of the arch both in Egypt and Assyria, but it is very uncertain whether its principles were understood in those countries, while it is comparatively assured that the Etruscans understood them perfectly. The only remaining Etruscan antiquities are the tombs, which are divided into two classes, those cut out of the solid rock, and those erected above ground. Some of these latter are built over a chamber excavated out of the rock, while others are built entirely above ground. Bas-reliefs carved on the **sarcophagi,** or stone coffins, remind us of both Assyrian and Egyptian art, but the tendency toward the circular form, both in plan and elevation, marks the distinguishing characteristic of the few monuments now remaining.

MODERN ARCHITECTURE.

ROMAN ARCHITECTURE.

39. With Rome, ancient history ends, modern history begins. Heathenism declines, Christianity dawns, and though with this new faith comes a new architecture, it must be understood that Roman architecture was fully developed before Christianity arose. The Roman people were not an imaginative race, and had few original ideas in architecture. Their early works were copied from the Etruscans and their later efforts were borrowed from the Greeks.

40. We now enter into that period of history when buildings were erected according to the second principle of architectural design referred to in Art. **1;** namely, the **arch.** The distinguishing characteristic of all Roman architecture is the use of the arch. In other countries it was used very sparingly, never as an architectural feature, and seldom as an engineering device. The Romans, however, were as profuse

in its application as their predecessors were persistent in its omission. In constructive ingenuity the Romans excelled all former efforts which the world had seen. Their buildings rivaled in scale those of Egypt, and in variety surpassed those of Greece, while they unsuccessfully tried to combine the beauties of each.

The attempt to Romanize the Greek orders cannot be considered a success. The Romans could not appreciate the simple grandeur and dignified beauty of the Doric order as it existed in Greece, and molded it on what we suppose the *Tuscan* to have been. It was used in forums or public squares, courtyards, and arcades, and for such purposes was more manageable than the pure Greek form, originally designed exclusively for sacred edifices. Before the addition of an independent base, the column was a characterless ordinance, and in this condition it may be seen in Fig. 30, which is a view of a part of the walls of the theater Marcellus at Rome. Their modification of the Ionic does not compare favorably with the original, as the Romans seemed neither to have liked nor to have understood it. In Greece the Ionic column was generally used between the antæ, or pier-like terminations of the side walls. In this position the voluted face was always parallel to the face of the architrave, and when used in temples, where it was necessary to carry the columns or pilasters along the side, as in the north porch of the Erechtheum, shown in Fig. 22, the Greeks caused an extra volute to be cut on the corner column, as shown at *D*. The Romans adopted this form, which had been designed for a special requirement, modified it to a certain extent, and used a four-voluted capital everywhere they required a detached Ionic

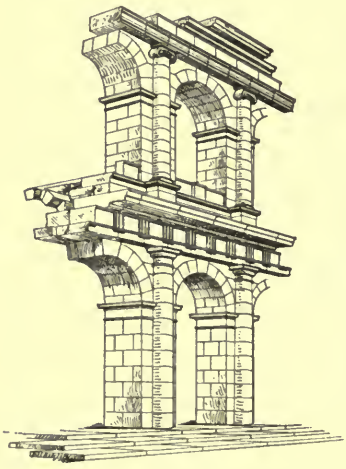


FIG. 30.

column, without apparently considering its original purpose. With the Corinthian order they were much more successful, and it became in Rome what the Doric was in Greece, the national style. Although the motive of the design was borrowed, the detail was not copied, and the Roman-Corinthian order assumed a new and beautiful character and a wonderful variation, without the loss of any of its distinctive features.

In their attempts to improve on the Corinthian, the Romans produced the *Composite order*, which was nothing more than a combination of the Ionic and Corinthian, without the addition of even one original idea. The order was not a popular one, and found favor only with the admirers of everything strictly Roman, simply because it was Roman. Roman moldings are the same as the Grecian moldings in general form, but different in contour. Roman moldings project more and are deeper cut than the Grecian, and their curves are formed with segments of circles, while the Grecian moldings always have a contour following the graceful curve of the *parabola* or *hyperbola*.

41. The Roman system of construction being entirely different from that of the Greeks, we find an entirely different conception of the purpose of the orders. In Greece the column and entablature were purely structural devices; the entablature consisted of the constructive details of the upper portion of the building, and was really supported on the column. In Rome the buildings were erected with heavy rectangular masonry piers, between which arches were turned to support the superstructure, and the column and entablature were applied as ornamental features to relieve the monotony of the continuous arcade. The column was placed against the center of the supporting pier, and the entablature was carried around the building above the crowns of the arches like a continuous belt course, as shown in Fig. 30. It is plain to be seen that the column and entablature form no structural part of the edifice, as the building would stand and serve its purpose equally well without them. Where a portico was carried beyond the front of a building, the roof was

usually supported upon a row of columns; but even in this the Romans differed widely from the Greeks, as in these porches they nearly always made use of the Corinthian order, while the only Grecian example we have of that order is the monument of Lysicrates, which has its columns attached. In *Advanced Architectural Drawing*, the Greek and Roman orders and their characteristic moldings are fully analyzed, and the relative values of their various members explained.

42. Roman temples, though modeled on the plan of the Grecian, never attained the same artistic effect. The changes in elevation, and the omission of columns when the arch replaced the lintel, impaired the simplicity of the design. The Romans built both circular and rectangular temples, and with great variety of treatment. In the rectangular temples a high **podium** or basement replaced the stylobate of the Grecian edifice, and the peripteral plan was less frequent than the prostyle. The temple of Fortuna Virilis, at Rome, and the Maison Carrée, in France, are examples of this style of Roman design, the latter being well preserved at the

FIG. 31.

present day, as shown in Fig. 31, though built in the first century of the Christian era.

As an example of the circular temples, the Pantheon at Rome, Fig. 32, is not only the finest example, but is also

one of the most magnificent religious edifices of the ancient world.

It was built by Hadrian, in the second century, its circular plan measuring 142 feet in diameter internally. The walls are 20 feet thick, and support a hemispherical dome, the crown of which rises 140 feet above the floor. Light is admitted to the interior through a circular opening, at the crown of the dome, 28 feet in diameter, being the simplest

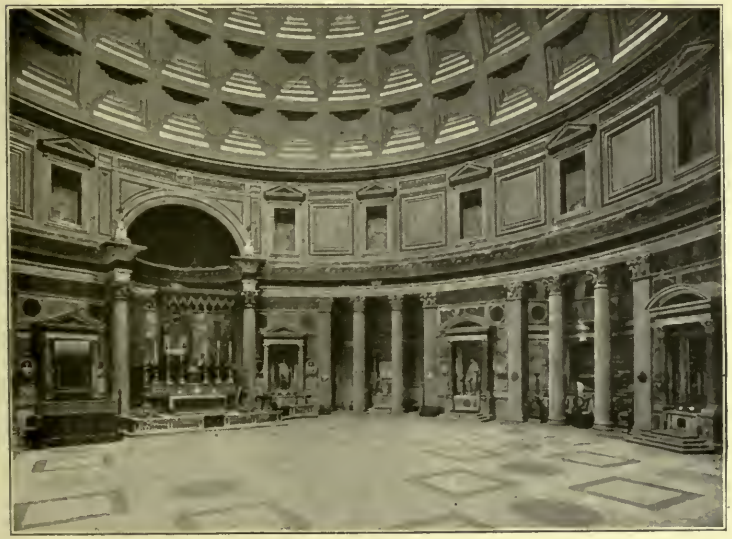


Fig. 32.

as well as the most impressive method of illumination conceivable. The dome is coffered on the interior, the moldings of the coffers, or deep panels, being so cut as to appear in correct outline when observed from below, as may be seen in Fig. 32, which shows a portion of the interior of the Pantheon. The dome, however, is not constructed of voussoired-arch stones, as are most of the Roman arches, but it is produced by corbeling, in the same manner as was the dome of the Treasury of Atreus, shown in Fig. 16. The side walls were deeply recessed and niched, to receive statues and altars, before which incense was burned to the gods. The

building is now used as a Christian church, however, and the niches and recesses contain emblems of the Christian faith, as seen in Fig. 32.

The exterior of the Pantheon, Fig. 33, which is reproduced from a restored model, was less impressive than the interior. The porch, with its twelve superb columns of Egyptian granite 50 feet in height, and its magnificent pediment and statues, was grand indeed, but it was ill-fitted to the circular building beyond. The capitals of the columns, minutely wrought in Pentelic marble, rank among the finest examples of the Roman-Corinthian order. The entrance to the temple is approached through three aisles, after the Etruscan style, but is effected through a single opening protected by two ponderous bronze doors. Taken as a whole, the Pantheon is certainly a masterpiece of the world's architecture.

43. The *Roman theaters* were similar to those in Greece, but were built on the top of a sloping side hill, instead of being hewn out of it. The decorations were more elaborate,

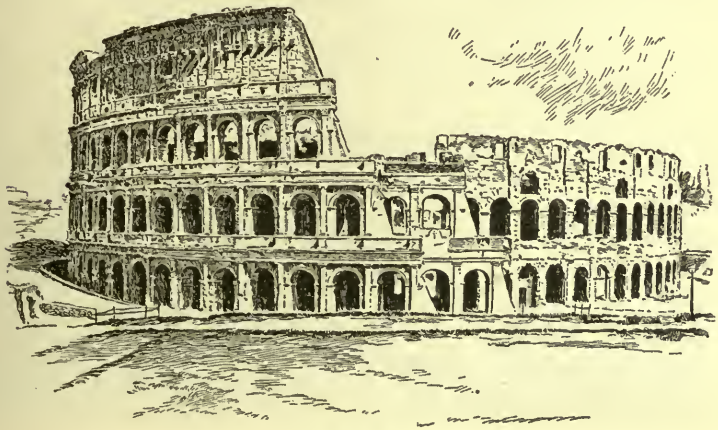


FIG. 34.

as is true of every other building which the Romans designed after Grecian examples, but the *amphitheaters* were essentially a Roman institution, and were strictly Roman in design. These consisted of circular or elliptical structures,

with seats in parallel rows all around, while in the center was the stage, or arena, where the performance took place. These performances were generally of the character of fights, either between armed men, called gladiators, or between a man and a wild beast, such as a lion or a tiger. They were very bloody contests, and tend to show the character of a people who could enjoy them. The largest amphitheater was the celebrated Colosseum, shown in Fig. 34, founded by Vespasian, 75 A. D.; it was 622 feet by 528 feet, elliptic in plan, and seated 87,000 persons, while, including the standing room, it would accommodate over 100,000.

44. Roman *tombs* varied greatly in form, some being circular, like their Etruscan prototypes, as was that of Cæcilia

FIG. 35.

Matella, Fig 35, while others were rectangular, like the Greek plan. They contained sarcophagi for the bodies, or niches and urns for the ashes of the dead, the Romans practising both cremation and burial. The round tombs formed

the prototype of a special form of Christian edifice of which we shall presently learn.

45. *Triumphal Arches* and *Columns of Victory* were objects of special attention in Rome, where the citizens cared more for these symbols of their successes than for

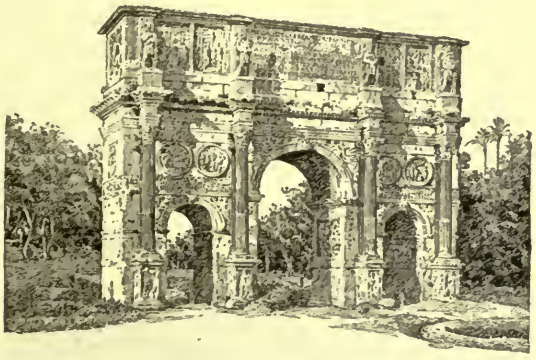


FIG. 36.

monumental temples dedicated to their gods. The triumphal arches were built across the principal streets and roadways, and were richly carved and inscribed with the date and description of the event which they commemorated. In Fig. 36 is shown the arch of Constantine, erected 312 A. D. in commemoration of Constantine's victory over Maxentius. This structure consists of an immense block of solid masonry pierced by three arched openings, each side of which a Corinthian column supports a richly molded entablature under an attic, or superstructure, which extends full width of the monument. Elaborate carvings and sculptures, both of detached figures and bas-reliefs, are executed on all sides, while over the center arch the dedication in Latin explains the occasion of the monument's erection.

46. The Roman *basilicas* are of great importance to us in later history, as they became the first houses for Christian worship, and from them the plans of our later cathedrals were developed. Originally built as a court of law, the basilica in plan was a rectangular hall twice as long as broad.

On each side was a row of columns which returned across the ends, forming a vestibule in front and an elevated tribunal court at the back. Above the aisles formed by these columns was a gallery, with another set of columns supporting the roof, and the staircase leading to the outside of the building. Back of the tribunal court was a semicircular *apse*, or recession, forming an alcove, where the prætor's, or chief judge's, seat was placed. These basilicas were covered with wooden roofs, and nearly all of them have been wholly or partially destroyed by fire.

In Fig. 37 is shown a longitudinal section of the Basilica Maxentius, or Temple of Peace, in Rome, originally started

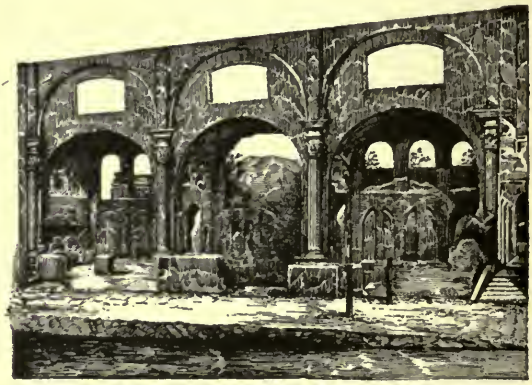


FIG. 37.

by Maxentius as a pagan temple, but completed and converted into a Christian basilica during the reign of Constantine, about 313 A. D. This was the first vaulted and fireproof basilica erected, in consequence of which it has withstood the ravages of time, down to the present day, to a sufficient extent for us to determine the details of its original design.

The Romans used the vault conspicuously in all of their structures, but they did not construct it as scientifically as they did the arches in their walls. When a room or passage was covered under a fireproof roof, a semicircular or

wagon vault was thrown across from one side to the other, with its abutments resting upon the side walls of the room. This vault was usually constructed of concrete laid over wooden centers or templets, which remained in place until the concrete set and hardened, and were then removed. Brick or stone arches constructed with voussoirs were sometimes built at regular intervals to support the centers, and in these cases the brick arches were permitted to remain, and form a part of the permanent vault, after the centers were removed. As the slightest displacement of the side walls would render the concrete crust of the vault likely to crack, it was necessary to make these walls very massive, so as to withstand the horizontal thrust.

47. In concluding this account of the classic and earlier styles of architecture, we take particular note of the legacy of certain architectural forms transmitted from generation to generation, some of which became perfected, as in Greece, while others, equally beautiful, may have been lost entirely in the ravages of war and strife that pervaded these thousands of years. The fact that every new religious faith was always followed by a change in architectural style, shows how closely allied are the studies of these two subjects. We observe also how, through all this history of heathendom, that the Egyptians and the Greeks, though pagans and idolaters, were a devout and conscientious people, and erected for their gods the most magnificent temples the world has ever seen. The Parthenon, Propylæa, and Erechtheum are monuments inspired by the most profound religious sentiment.

In strongest contrast to this, are the architectural monuments of the Romans. Colossal as the temples of Egypt, magnificent as the palaces of Assyria, their structures express no higher feeling than an abnormal desire for ostentatious display. Living in luxury, upon the plunder of successful wars, the Romans gave more thought to the erection of monuments that would remind them of their successes, or appease their appetites for enjoyment, than to the dedication of temples that would inspire them with religious fervor.

Of the former class are their triumphal arches and pillars of victory, while the famous Colosseum, with its bloody history of gladiatorial contests, is an example of the amusement they craved.

Their desire for splendor, however, led them to the most wonderful engineering feats of the times, and after they discovered the principles of the voussoired arch, there was hardly a limit to their engineering enterprise. Aqueducts, bridges, sewers, and vaulted cellars were constructed everywhere, and in their architecture they arched every opening that appeared. They copied the Greek temples in plan, but removed columns wherever they saw fit, and boldly threw an arch across the intervening space. So we can safely assert that the most striking characteristics of Roman architecture are the persistent use of the arch and the tendency to extremely elaborate decoration.

The Romans adopted the Greek orders, but elaborated them They seldom used detached columns on the exterior of a building except for porticos, as may be seen on the Pantheon, Fig. 33. Their buildings were essentially constructed of solid masonry walls, pierced with arched openings, between which columns were planted against the piers, purely for decorative effect. This treatment may be seen in the Colosseum, Fig. 34, and the arch of Constantine, Fig. 36. The Romans were the first to superimpose the different architectural orders in stories, as in the theater Marcellus and Colosseum; and the podium, or pedestal, with which they supplanted the Greek stylobate, they used independently under single columns when occasion required, as in the arch of Constantine.

EARLY CHRISTIAN ARCHITECTURE.

TRANSITIONAL STYLES.

48. For the first traces of Christian architecture, we must turn to the *catacombs* in and around Rome. These were underground galleries hewn out of the soft rock, where

the persecuted Christians were compelled to retire to hold their services of worship and to bury their dead.

This labyrinth of excavated passages dates back to the first century of the present era, and for over three hundred years it was the only place where those who professed Christianity could assemble without fear of attack by the Roman soldiers. In the year 313 A. D., Constantine I, emperor of Rome, became converted to the Christian faith and issued the famous "Edict of Milan," which extended to the Christians civil and religious rights and privileges equal to those enjoyed by the pagans throughout the empire. Thus freed from tyrannical constraint, the Christians immediately sought some suitable buildings in which to set up their church. The existing tombs and temples were too small to adapt to a form of worship where there was likely to be a large assemblage of people, and though several of the larger ones were converted into Christian churches, they were afterwards abandoned for more commodious quarters.

49. The Roman *basilica* was finally selected as the best existing structure in which to hold the services of the Christian church, and so suitable did it prove to be that down to the present day few alterations have been made in its plan. The semicircular apse, raised and railed off from the main part of the building, was a most suitable place for an altar, while the wide, open aisles provided ample space for the assemblage of the congregation.

When structures were later erected purposely for the use of the church, the same plan was adhered to and the buildings were still called basilicas; but instead of keeping the aisles all parallel with the length of the building, a cross-aisle, called the **transept,** was introduced near one end, and the sides of the building were extended somewhat at the extremities of this aisle, thus converting the rectangular plan to the form of a cross. The center aisle from the transept to the entrance then became known as the **nave** of the church, and the part from the transept to the apse was called the **choir.** The nave was usually built to extend above the

roofs over the side aisles in order to form a clerestory for the admission of light, and windows were introduced in the side walls for the same purpose; but the walls at the ends of the church, and particularly those of the apse, were left solid in the early basilicas, and decorated with paintings and symbolic designs in mosaic.

The first three edifices erected solely for the purpose of Christian worship, were the basilicas of St. Peter, St. John Lateran, and St. Paul. The first named was by far the finest, being 380 feet long and 212 feet wide. All three

FIG. 38.

possessed five aisles (though later basilicas were limited to three), and the central aisle, or nave, of St. Peter's measured 80 feet across.

The structures each fronted on a large open courtyard called the **atrium**, where converts to the faith, and candidates for baptism, assembled during certain services held in the church, to which they were not admitted. The atrium was considered a most important adjunct to the early basilicas, but was abandoned when, after the fall of the Roman Empire,

the church became an independent power and structures were erected in remote districts, away from the influence of their early Roman prototypes.

Of the above three edifices, St. Peter's was demolished and rebuilt in the fifteenth century, St. John's was extensively altered, and St. Paul's was destroyed by fire in 1821. This church has been rebuilt, however, and stands today almost in its pristine splendor. Fig. 38 shows the interior of the church as restored, while in Fig. 39 is shown the cloisters with their eccentrically carved columns and capitals.

FIG. 39.

50. With the fall of the Western Roman Empire in A.D. 476, the Christian religion became diffused among two great races of people. All in the eastern part of Europe were of Slavonic origin, while those in the west were of Celtic or Teutonic races, and a line drawn from Memel, on the Baltic Sea, south to Spalatro, on the Adriatic Sea, would practically divide these two peoples, and cut Europe in nearly equal portions.

The change in style which marked the architecture to the

east of this line was known as *Byzantine*, from the city of Byzantium (now Constantinople), where it was developed, while in the west, the style was called *Gothic*, from the race of people called Goths, who overthrew the Western Empire. Previous to this change, however, there existed a transitional style in both the east and west, which was simply an attempt to adapt the classical forms to Christian purposes. This transitional style was known as **Romanesque,** and in eastern Europe it was perfected in the reign of Justinian (A. D. 527 to 564), when it became entitled to the name Byzantine; but throughout western Europe the Romanesque or transitional style existed until the seventh century.

Byzantium was to the Eastern what Rome was to the Western Empire, and the Byzantine style, by emphasizing every detail that distinguished Christianity from paganism, became an original school of art.

51. The *tombs* of the Romans formed the prototype of an important class of ecclesiastical structures called *Baptistries.* These were circular churches, usually erected in the vicinity of cathedrals, where sacramental services were held, such as burial, baptism, or marriage. They are of particular interest as showing the transitional stages between the pagan tombs and temples, with their ornament and decoration entirely on the outside, and the Christian edifices, with their colonnade and decoration entirely within the walls. It will be remembered in connection with the Grecian and Roman temples, that they were surrounded by columns, and possessed a rich entablature which in many cases was not only elaborately sculptured, but was also brilliantly colored. We arrive now, however, at an epoch where the direct reverse is the order of design. Christian churches up to the eighth century were plain and unpretentious on the exterior, but whether modeled on the plan of the basilica, as in the west, or on the style of the pagan tomb and temple, as in the east, the interior was decorated with carvings, frescoes, and mosaics to an extent never before attempted.

52. Early Romanesque architects never covered their rectangular structures with the Roman barrel vault, but frequently constructed domes over their circular buildings. This domical vaulting, however, was only used as an internal ceiling, which they covered with a false wooden roof.

FIG. 40.

The Church of St. George at Thessalonica, of which Fig. 40 is an exterior view, and Fig. 41 a plan, is a fine example of this class of buildings. It is a circular structure 79 feet in diameter, whose walls, 20 feet in thickness, are indented by seven niches, two of which serve as entrances. The dome is hemispherical and pierced with semicircular windows, but is covered and concealed externally by a wooden roof. This interesting structure was erected about the year 400 A. D., and shows clearly the advancement and progress of Christian architecture towards the adoption of the exterior dome, which later marked the distinguishing characteristic of the **Byzantine style.**

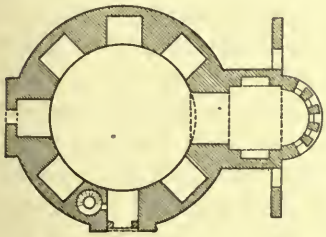


FIG. 41.

BYZANTINE ARCHITECTURE.

53. The principal characteristic of Byzantine architecture lies in its development and application of the principle of the dome. Domical structures are as prominent in the Byzantine style as arched openings are in the Roman, or trabeated openings in the Grecian designs. The Romanesque architects domed their circular and rectangular buildings

to secure an impressive interior effect, but the Byzantine builders used this hemispherical detail to give character to the exterior, as well as to the interior of their edifices. The Byzantine dome was a progressive step from the Roman vault, but it was constructed on more scientific principles than its pagan predecessor, as the people that developed it were inspired by higher and more sincere motives than the constructors of temples to pagan gods, or the builders of theaters for Roman entertainments.

The system of plan had to be altered when the dome superseded the vault, but the alteration was such as was required by the construction, and not a change suggested by the purpose of the building.

54. In Fig. 42 is shown a diagram of the Byzantine system of construction, *a b c d* being the rectangular plan which is covered by a circular dome. Four heavy masonry piers, *a e*, *b f*, *c g*, and *d h*, are constructed at the four angles of the plan, the spaces between them being spanned by four arches, as *e k f*, *f l g*, etc. Thus far the construction does not differ widely from that practised by the Roman architects; but in order to dome the enclosed area the angles were also arched over until, at the crowns of the first arches, the plan became circular, as at *k l m n*. The spherical triangles thus formed at *e n k*, *f k l*, etc. are called **pendentives,** and are as characteristic of the Byzantine style as is the dome itself. Over this circular opening *k l m n*, the dome *o p q* was constructed, resting directly on the pendentives in the earliest structures, but raised on a cylindrical superstructure, as *n o*, in the more advanced buildings. The cylinder was pierced by numerous windows, to light the interior, and the weakness in construction, due to these perforations, was compensated

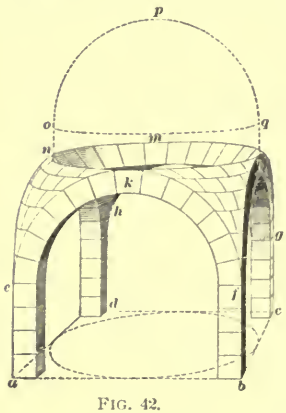


FIG. 42.

by the construction of buttresses (against the piers between the windows), to take up the thrust of the dome.

55. Byzantine churches, as a rule, were nearer square than oblong, and in consequence of the system of construction, square piers connected by arches supported the roof over the center of the building instead of rows of columns connected by arches, as in the Roman basilica. This roof was always a dome, and joined to it were barrel vaults or semidomes of less magnitude. Small columns were introduced for supporting galleries and for railing off the central portion of the building from the surrounding parts. The *apse*, or the semicircular termination to the choir, was richly decorated and was invariably the principal feature of the church.

56. The best example of the Byzantine style is the great Church of Hagia Sophia, at Constantinople. This edifice was begun by Justinian in 532 A. D., and he announced his intention that it should be "the grandest monument ever erected by man." The governors of even the most distant provinces of the empire were ordered to ransack all the ancient buildings for sculptures, precious marbles, and works of art. Eight columns of white marble were brought from Palmyra, eight more of green marble were stripped from the Temple of Diana, at Ephesus, and shiploads of costly relics were brought from all parts of the empire to form a part of this great edifice. Ten thousand men toiled night and day for six years, and the royal treasury and private purse of the emperor were exhausted by the prodigious expense, but the church was completed, and if not up to the ideal of the emperor, it certainly was one of the grandest architectural achievements the world has ever seen. Its plan is very simple, though complicated in appearance, as shown in Fig. 43. It consists of a rectangle 229 ft. $\times$ 243 ft., in the center of which four piers, each 25 feet square, carry the semicircular arches and pendentives on which the great dome rests. Right and left of the central square, four columns support semicircular arches under the women's gallery, and on the

other two sides the semicircles are vaulted with half domes, as shown in Fig. 44. Each half dome is penetrated by three supplementary vaults, as shown, the middle ones being tunnel or Roman vaults, which terminate in the apse on the east end of the church and in the entrance on the west. All the masses were disposed with studied reference to the

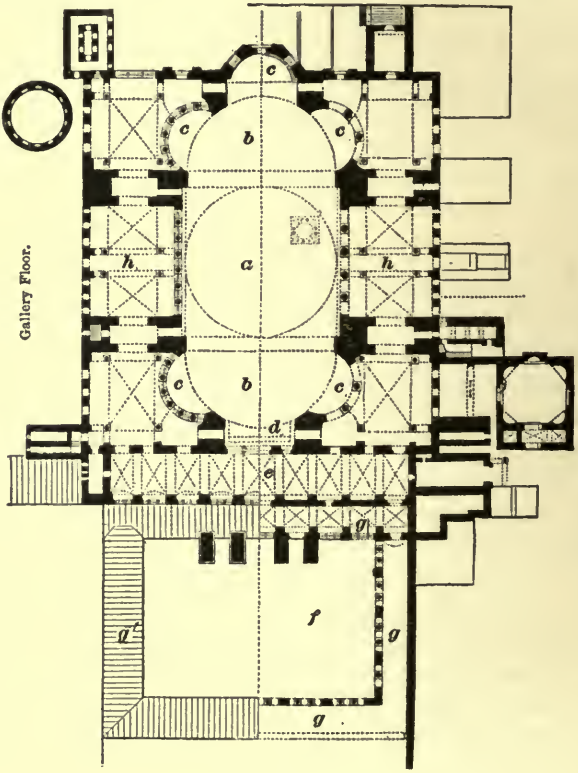


Fig. 43.

resistance required by the many and complex thrusts exerted by the dome and other vaults, and the fact that the earthquakes of thirteen hundred years have not demoralized the structure, is the best evidence of the sufficiency of these precautions.

In Fig. 43, *f* represents the atrium, or open court, sur-

rounded by a colonnade *g*, *g*, which communicates with the

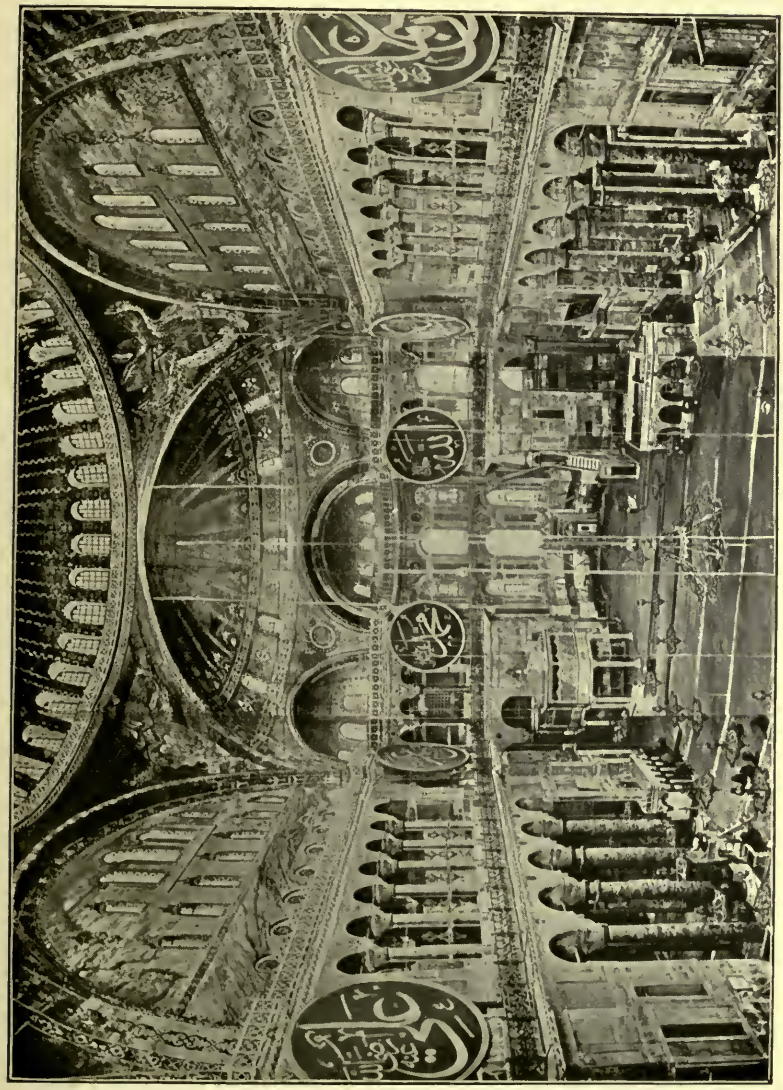


FIG. 44.

main building through the immense *narthex*, or vestibule, *e*; *d* is an archway connecting the vestibule with the nave *b a b*;

h, *h* are the side aisles; *c*, *c* are curved colonnaded recessions from the semicircular ends of the nave, which, as shown in Fig. 44, are surmounted by semidomes which pierce the large semidomes; *b*, *b*, in Fig. 43, shows the plan of these large semidomes, and *a* the plan of the central dome which crowns the structure. Thus was secured a noble and unobstructed hall of unrivaled proportions and remarkable beauty, roofed over by a combination of half domes, which increased in size as they led successively up to the stupendous central vault which crowned the whole. The imposing effect of this loftily poised dome, so disposed that its summit is visible from any part of the nave, is not surpassed by any interior ever designed.

Simple as is the means of securing this remarkable result, the actual effect is one of great intricacy of mass and of unceasing gradation of parts. From the small arcades and semidomes that surround the aisles, galleries, and apse, to the stupendous vault that hangs with little apparent support, like a gigantic bubble over the nave, there is a continuous change of form where one part grades or blends into another, that impresses the beholder with a feeling of unbroken repose. The right-hand portion of Fig. 43 shows the arrangement of the plan at the floor level, while that on the left side shows the arrangement at the gallery level, and also the roof over the colonnade of the narthex, as at *g'*.

57. The noble planning and construction of this great edifice is no more remarkable than the treatment and scale of its interior decoration and design. It is to Byzantine architecture what the Parthenon was to the Greek. With little external beauty, except the beauty of perfect construction, it is internally one of the most perfectly composed and beautifully decorated halls of worship ever erected. Contrasted with the simplicity of the Parthenon, it displays the complexity of an organism of admirably related parts. Dimmed by the lapse of centuries, and disfigured by the vandalism of the Moslems, into whose hands it has fallen,

the interior of Hagia Sophia, by the harmony of its coloring and the grandeur of its parts, is one of the masterpieces of all time.

Externally the church possesses little attraction, and the numerous additions at the hands of the Mohammedans have

FIG. 45.

detracted from the purity of the original design. As a system of domical construction, and a type of its style, it still exists, however, in much of its original purity, Fig. 45.

58. How widely Byzantine influence spread, even into western Europe, is proved by the existence of such buildings as the Church of St. Mark, at Venice, in Italy, Fig. 46, and the Byzantine Church of St. Front, at Perigueux in France. Purely Byzantine Churches do not exhibit as much exterior ornamentation as is seen on the Church of St. Mark, as this edifice was erected four centuries after Hagia Sophia, and was consequently contaminated by local influence. But, though subjected to numerous alterations during the Gothic

period, St. Mark's exists today in much of its original structural grandeur of a purely Byzantine type.

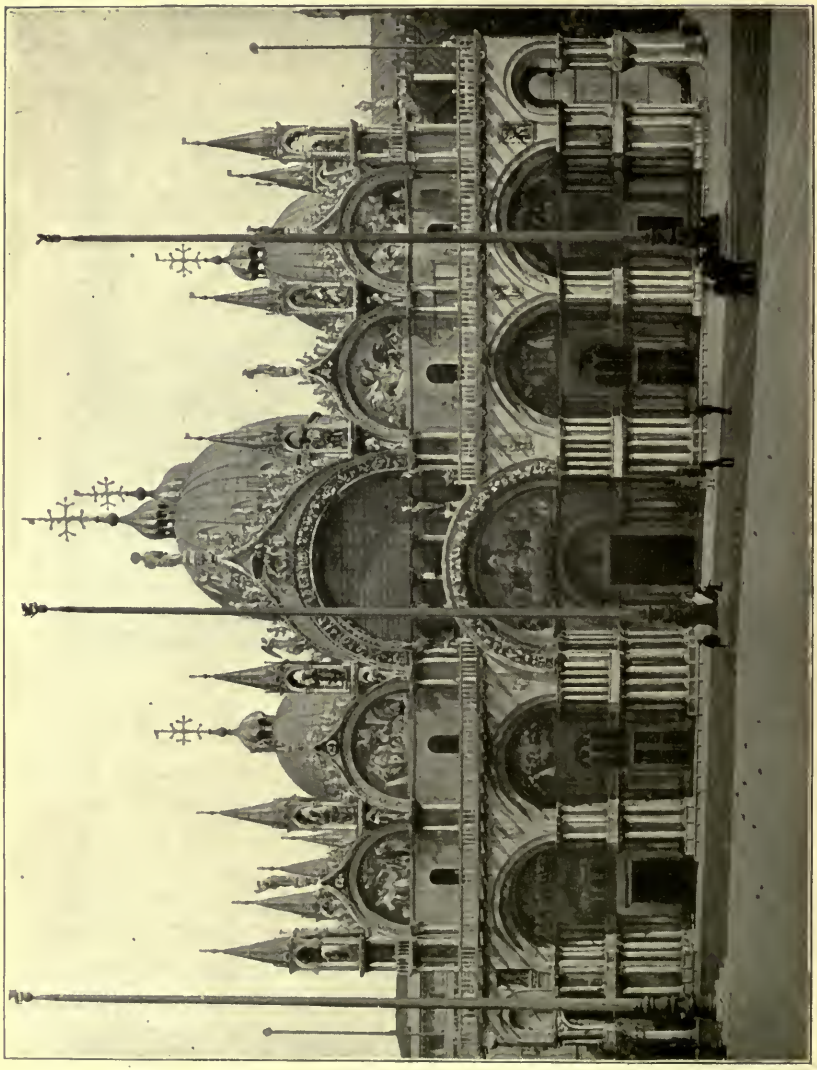


FIG. 46.

The Church of St. Front, at Perigueux, however, though copied after St. Mark's, was structurally inferior to its

prototype. The form and outline of the Byzantine style were imitated, but the district was so remote from the home of Byzantine art, that the system of construction was but imperfectly understood.

MEDIEVAL ARCHITECTURE.

INTRODUCTION.

59. The fall of the Western Roman Empire in 476 A.D., marked the beginning of a new architectural era throughout all Europe, except in the Byzantine Empire. The so called "Dark Ages," which followed this event, may be considered as the formative period of western civilization, during which the barbaric conquerors of Rome were gradually Christianized, and subjected to the authority and educational influences of the church.

Under these conditions a new architectural style was developed, founded upon the traditions of the earlier Christian builders, but modified in different regions by local influences. The prevailing characteristics of the style were at first essentially Roman, for Rome soon recovered her antique prestige as the leading European city, and Roman monuments, covering the soil of southern Europe, were a constant object lesson to the builders of that time. To this new architecture of the West, which, in the tenth and eleventh centuries, first began to achieve monumental results, the general name of **Romanesque** has been commonly given, though it differed widely under the local influences of different countries.

Romanesque architecture was distinctively ecclesiastical. Civilization and culture emanated from the church, and the requirements and discipline of the religious orders gave form to the builder's art. The basilican style of building, which had so well served the purposes of the church, in the earlier centuries and on classic soil, did not suit the new conditions, except so far as its plan was concerned. Corinthian columns, marble incrustations, and splendid mosaics

were not to be obtained in the forest lands of France and Germany, and the priests and monks sought to erect with unskilled labor churches of stone in which the general arrangement of the basilica plan should be maintained, but with simpler adjuncts, and as far as possible in a fireproof construction with vaults of stone. The struggle with this problem underlies the entire system of Romanesque design, while the solution of the problem characterizes the development of the Gothic style.

THE ROMANESQUE STYLE.

60. The aim of all good architects, from earliest antiquity, has been to build permanently and to build nobly—to construct a building of materials sufficiently refractory to withstand the ravages of fire and age, and to put those materials together with sufficient strength both to defy the savage onslaught of the invader, and to resist the slower but surer disintegration of time and the elements.

The great difficulty in all the medieval churches was the question of roof. Side walls and partitions could be built of stone, but the roof must be of some other material, or require the invention of a new device to hold stone in place. Now, it is the invention of just these devices, so numerous in Romanesque and early Gothic architecture, that makes medieval construction of such vast interest and importance to the architectural student. The medieval builder plodded along in his work until he struck an obstacle, then he quietly overcame that obstacle, and proceeded without boast or brag of his achievement.

The churchman of the eleventh century was simple, unassuming, and industrious. He thought little of his personal needs, but devoted his whole life to his church and faith. His patience and perseverance require no nobler monuments than the great Gothic cathedrals of the succeeding centuries, which never would have been completed had the medievalist not tried again and again to accomplish results that he had repeatedly failed to attain.

The Romans, when they wished to erect grand monuments of public utility, could not only send to the spot, no matter how remote, an army of soldiers, but by their tyrannical system of government they could compel the very inhabitants of the locality to desist from all other employments and work for the emperor of Rome. They thus achieved by a multitude of hands those prodigious results which today stand monuments not only to their enterprise, but also to their despotism.

Had the builders of the middle ages desired to pursue this course, where would they have found the army of workmen? In a country without stone, without money to buy it, without beasts of burden to transport the material if they could buy it, without even roads over which to travel, how could these people even attempt to follow the course of their Roman neighbors? The provinces were almost continuously at war with one another; each abbot and each lord was, in his own opinion, absolute sovereign over his entire domain (and often a part of his neighbor's, hence the frequent wars), and any attempt to erect a monumental structure would have been regarded with the most suspicious jealousy by the lord of each neighboring fief, the jealousy increasing in proportion to the smallness of the country over which each held power.

For the following reasons, then, the religious orders were the first who could by themselves undertake important building.

First, because they alone could gather together at one place a number of men sufficiently united by a single paramount thought, subject to discipline, freed from military service, and possessors, in the name of the church, of the land on which they lived.

Second, because the religious orders amassed property and improved it under a regular administration; because they joined in amicable intercourse with neighboring establishments; because they plowed the uncultivated lands, laid out roads, and with the fruits and tolls of their industries bought quarries and woodlands, built workshops, and offered to the

peasants guarantees which were relatively certain. Thus the church lands were rapidly populated and improved, while those of the laity and nobility were continuously devastated by war.

Third, because the religious orders were able, thanks to the comparative stability of their organization, to form, with their monasteries, schools of artisans, subject to regular apprenticeship, clothed, fed, maintained, and worked under the same directing influence—schools which preserved traditions and recorded improvements.

Fourth, because the churchmen alone, at that time, extended their influence to a distance by founding establishments subject to the mother abbey. Hence, to the activity of religious orders the art of construction owes its rise from barbarism in the eleventh century. We will now consider how this rise took place, how it developed, and how it ended in the grand cathedrals of the thirteenth century.

61. However rich and powerful the monks might be, compared with the feudal lords and barons, they could not hope to build as the Romans built. They endeavored to erect solid and durable structures, but practised the closest economy, on account of the scarcity of materials and men.

To follow the Roman method of making their structures a mass of rubble between two faces of ashlar or brick, demanded more laborers than they had at their disposal. To build of enormous blocks of hewn stone, carefully cut and set, required means of transportation far beyond their facilities. So they pursued a middle course. For the principal points of support they used cut stone as a casing and filled in with rubble, and for other walls, a thin facing of ashlar enclosing a concrete filling made of pebbles and mortar.

The Roman buildings, by reason of the absolute stability of the different points of support, and the perfect concretion or solidifying of all the upper parts, presented immovable masses, as if they had been cut out of a single block. The Romanesque architects soon realized the fact that their buildings presented no such stable conditions. The piers,

formed only with a veneering of solid stone and put together with a poor quality of mortar, and the walls, unbonded throughout their height, suffered from unequal settlement, causing ruptures, and, consequently, serious accidents. Towards the beginning of the eleventh century, these drawbacks became even more serious, for the Romanesque architects wanted to *vault* their structures. They had inherited a knowledge of the value of the Roman vault, but were unable to use it on account of the lack of sufficiently powerful support in the structures they had built. Their intelligence and ingenuity, however, made up for this lack of power and material. The Roman vault will sustain itself only when its supports are perfectly stable; for it is formed of a homogeneous crust of concrete, which, owing to its lack of elasticity, breaks to pieces if small crevices appear in its curve. Unable to furnish sufficiently stable walls to support vaults, as the Romans did, the medieval builders invented new methods of holding them firmly. The earliest of these attempts ended in failure, but from the very beginning, we can see the creation of a new system of building founded upon the principle of *elasticity*, in contrast to the principle of *stability*, or rigidity, practised by the Romans. The Roman vault, with but few exceptions, is built of rough stone concrete, and though sometimes strengthened by arches of *brick*, these arches are buried in the concrete and thereby become a part of it. In contrast to this method the Romanesque builders built their vaults not of concrete, but of hewn stone laid in mortar, but after the pattern of the old style Roman cradle vault, or, as it is sometimes called, a wagon vault, or barrel vault, as shown in Fig. 47, of which *a b d c* is the ground plan.

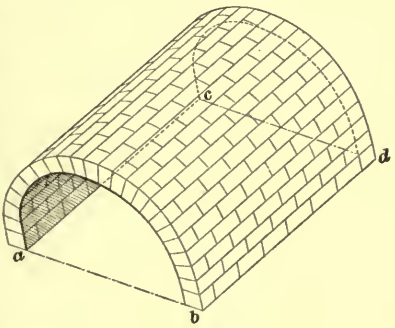


FIG. 47.

62. The mediæval artisans at this time knew nothing of the laws of statics, and the thrust exercised by the arch upon the side walls being something entirely new to them, they neglected to provide sufficient means to withstand it.

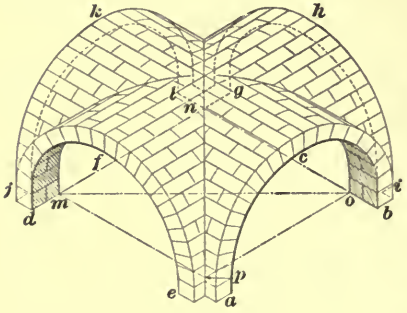


FIG. 48.

Consequently, at the end of the eleventh century, many churches and halls, which had been built and vaulted but fifty years, fell in ruins from the collapse of their vaults, and had to be rebuilt. These accidents, though unfortunate, bore good fruit; they were a lesson to the builders, and showed them that other means must be provided to accomplish the end they desired. These same builders knew that a groined vault, such as is shown in Fig. 48, exercised its pressure and thrust only at the four supports receiving the *skewbacks*, as the wedge-shaped abutting voussoirs, shown at *a*, *c*, are called; and, recognizing

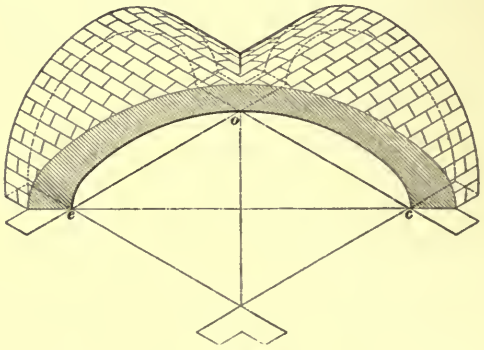


FIG. 49.

the advantage of the groined vault, they tried to replace the cradle vault with it, even in the naves composed of *oblong* compartments, and thereby bring all the weight on piers, which they hoped to be able to render stable. But new

difficulties immediately arose. The Roman groined vault can be built only over a square space, as *m n o p* in Fig. 48, and it was necessary to find a new combination of groined vaults adapted to the form of a parallelogram.

The building of a Roman groined vault requires four semicircular centers, or templets, one for each end of the intersecting vaults *a c b*, *d f e*, *g h i*, and *j k l*, as in Fig. 48, and also two diagonal centers *m o* and *n p*, whose curve is not a semicircle, like the other four, but an ellipse, as shown in Fig. 49, in which the two front ends of the vaults are removed to show the line of intersection and form for the center *e o c*. In Fig. 50, let *A B* represent the diameter of a cylindrical vault and *A f B* its semicircular outline; then *C B*, drawn at an angle of 45° with *A B*, will represent the line on which the two vaults intersect. Now, as *o′ f′*, the height of the curve of intersection, is always equal to *o f*, the height of the semicircular outline of the vault, and *o′ C*, half the diameter of the curve of intersection, is greater than *o A*, half the diameter of the semicircle, it follows that *C f′ B* can-

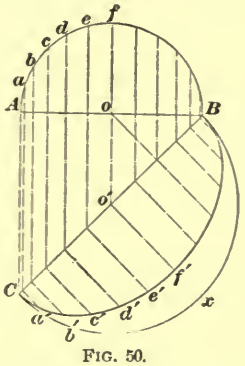


FIG. 50.

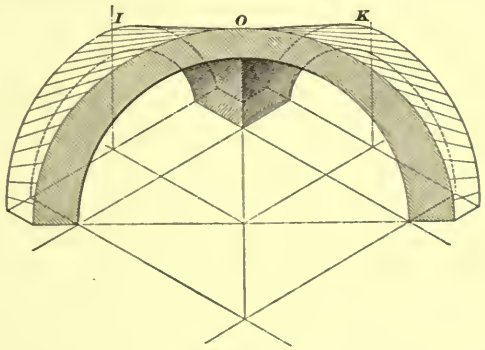


FIG. 51.

not be a semicircular curve. Simple as this geometrical problem is, it appeared too complicated for the Romanesque builders, and they could not produce a center with the curve

of the ellipse $C f' B$. Accordingly, having described a semicircle upon the diameter $A B$, in order to cut out timber centers of the four arches generating the vault, they described a second semicircle $C x B$ upon the diameter $C B$, in order to cut out the two diagonal centers. Thus, the keystone at O in Fig. 51, where these two vaults intersected, was on a higher level than the keystones at K and I in the generating arches, and the vault, instead of being the result of the intersection of two semicylinders, was a nameless compound of curved surfaces, slightly resembling a dome.

Upon this principle is based the whole system of vaulting during the middle ages; and, as all the details characteristic of Gothic architecture are indirectly traceable to its system of vaulting, we see that it would be impossible to design a Gothic building today without an intelligent understanding of the fundamental principles of its vaults. The above principle is also important on account of the fact that though they were trying to use the Roman vault, they modified it to such an extent that it became a different device entirely, and the builders of the middle ages were thus suddenly emancipated from all the bad influences of the Roman style, and left free to develop a new style from the raw material they had at hand, in the same manner that the Byzantine builders developed an original style, by careful study of the structural principles of the dome.

63. Having modified the Roman vault in this way, the next problem was to apply it to oblong plans, for the builders had already realized the danger of applying cradle vaults to wide spans. The Roman groined vault, applied to oblong spans, with a wide intersection, required the arch over the narrow span to be *stilted*, as shown at e, f in Fig. 52, and the lines of the groins $a b$ and $c d$ were not straight, but formed the compound curves $a b$ and $c d$. This was a still more complicated problem for the Romanesque builders, but they solved it in the same manner as before, by cutting the centers, both for the ends and for the intersections of their vaults, in the form of a semicircle. But with this

simple solution another difficulty arose: The lines of intersection, or groins, in the Romanesque vault were forced by circumstances to be straight in plan, as they were built over semicircular centers; but this produced such a warped surface in the vault covering itself, that the groins were projecting at the springing point and indented at the crown. Fig. 53 shows the earliest form of the Romanesque groined vault with the arch *e f g* over the end *r s* of the oblong space *r s u t*, and the arch *h i j* over the side *s u*. The intersecting curves *m n o* and *p n* over the diagonals *r u* and *s t* are semicircles, but the groins inside the vault do not produce a continuous angle on which a bead can be worked, as is the case when the arches are two intersecting cylinders, as in Figs. 48 and 52. A section through the corner on the line *a b*, Fig. 53, would produce an exterior angle, as shown at *v*, with the bead worked on the corner, but as you follow the groin up into the vault, the angle becomes more and more obtuse until it reverses itself and at *c d* becomes an interior angle, as shown at *w*. This was very unsightly, and the builders immediately set to work to improve on it.

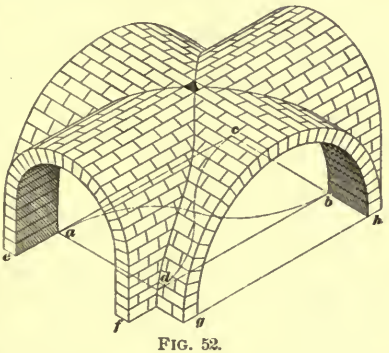


FIG. 52.

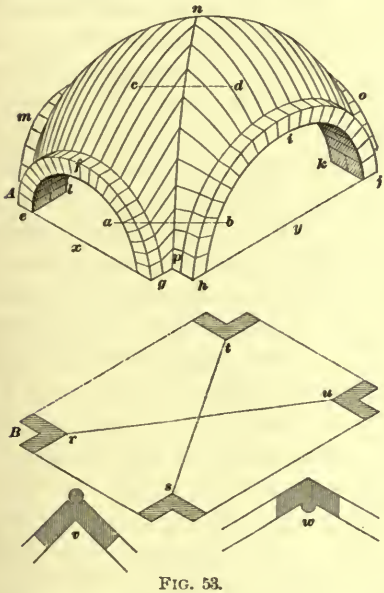


FIG. 53.

64. It was at this time that the pointed arch made its appearance, and there is little doubt that its invention or adoption was the direct outcome of the above cited difficulties in groined work. Fig. 54 shows a section of a cradle vault which has failed on account of its side walls *c* being too light to withstand the horizontal thrust. The dotted line shows the original position of the wall and vault, and the top of the wall *a′ b′* now occupies an altered position, as at *a b*. It is therefore clear that the vault has failed by parting at the crown on the inside, or intrados *d*, and by breaking at the haunches on the outside, or extrados *e*. When the walls separate enough to let the keystone *f* drop out, the entire crown of the vault will fall. It is very evident, then, that if the crown of the arch were higher, as at *o*, it would have much farther to settle before the keystone would drop out, and the arch would be much more likely to fall by the walls *c* tipping over entirely, than by the crown of the arch falling in. Therefore, by striking an average between the point where the arch crown would stand till the walls fell, and the point where the walls would stand till the arch fell—or, in other words, proportioning the parts of the arch so that its own strength for support is equal to the strength of the walls to resist its thrust—we have an arch of the form shown in Fig. 55, which is simply the pointed arch that marks the dawn of the Gothic style. It was to this end that all the experiments and failures of the Romanesque builders led, and it was in this arch that all their difficulties were overcome. Excessive horizontal

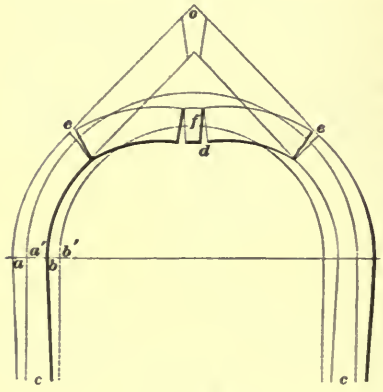


FIG. 54.

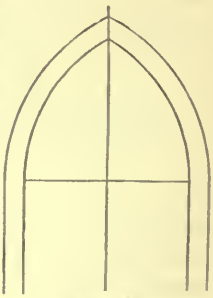


FIG. 55.

thrust is done away with, intersecting vaults of any size are possible without difficulty or danger, vaults over oblong spaces are as simple as over square plans, groined vaults are formed with ribs that are straight in plan, and the curves at the intersections, or diagonals, are always semicircles.

65. In Fig. 56 we have a pointed groined vault with the groins built upon semicircular centers *c d e* which are higher at their middle point *o* than the crowns of the pointed arches *a* and *b*. The crown of the vault is, therefore, curved in the same manner, though not so much as the crown of the vault in Fig. 53, but the groins in the pointed vault are perfectly straight throughout their length and can be worked or beaded as desired. As said before, the method of building these arches was not that of the Romans—a solid concrete mass with brick arches embedded in the concrete to give it strength while it was setting; but, on the contrary, the Romanesque vault was composed of small panels or slabs laid upon the ribs or groins for support. At each end of the vault an arch was turned and also at the intersection or groin, and upon these arches boards were laid, and the mason work of the vault was then built over the boards, the arches remaining in place and thereby forming a sort of permanent center. These centering arches soon became more and more numerous as the vaulting became more complicated; and in order to ornament them, they were carved into rich moldings and their intersection covered with a *boss*, or rosette, carved in the form of a bunch of leaves or flowers.

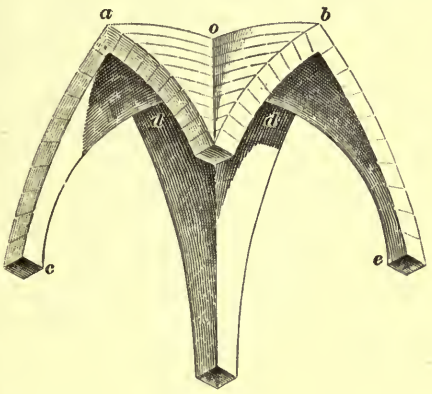


FIG. 56.

Fig. 57 illustrates the constructive system of the late

Romanesque or early Gothic church; the transition from one style to the other being so gradual that an exact line of distinction cannot be drawn. The walls *a* of the nave *h* are supported upon the columns *b*, and the roof over the nave is vaulted in the Gothic system just explained. The groins, or ribs, of these nave vaults rest on the piers *c*, which are directly over the columns *b*, and the thrust of the nave vaults

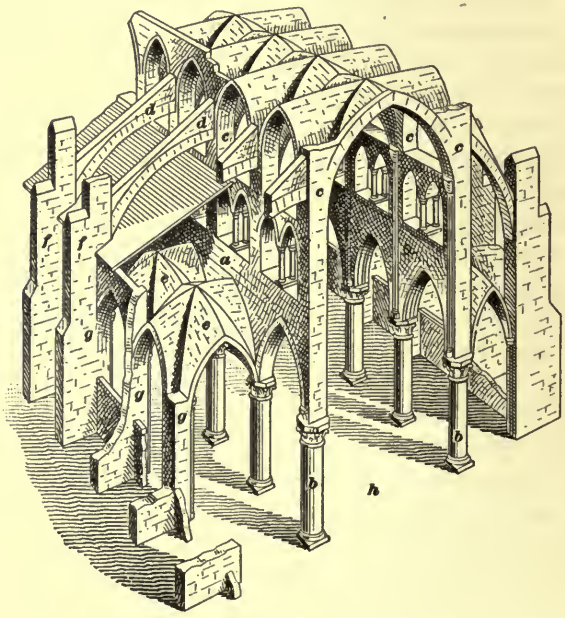


Fig. 57.

is carried by the flying buttresses *d* across the aisle vaults *e* to the solid buttresses *f*, the lower portion of which also receives the thrusts from the aisle vaults at *g*, thus illustrating the two great principles of Gothic construction: concentration of strains upon isolated supports, and balanced thrusts. The former of these principles was made possible by the substitution of the groined for the barrel vault, which led to the concentration of masonry at the points where the groins rested, and the building was constructed as if upon legs, as may be seen in Fig. 57.

66. The second of these Gothic principles of construction is in direct opposition to the Roman system of vaulting, where the thrust of the vault was resisted entirely by the inertia of a mass of masonry piled against it in the abutments. In Gothic architecture, thrusts were as far as possible resisted by counter thrusts, and the final resultant pressure was transmitted by flying buttresses to the external buttresses at convenient points.

The pointed arch did away with the tremendous thrust of its Roman ancestor, but it had some thrust of its own, and in order to diminish this thrust sufficiently to make a light wall or pier a safe support, the pointed arch would be too high in proportion to its width to look well. Here, then, was a defect in this new form which had emancipated the middle-age builders from their most dangerous difficulties. Man no sooner admits a principle than he discovers its imperfection.

67. During all the Romanesque period the architects had made vain attempts to reconcile two apparently contrary principles, namely, economy of material with a modified form of the Roman vault. The success they achieved was in the invention of a new vault, descended from, but in no way related to, the massive construction of the Romans. In some parts of France the builders adopted the Byzantine form of construction, as shown in the Church of St. Front, at Perigueux, built in the tenth century. But the constructors of this church were no such intellectual men as their northern neighbors. The constructors of St. Front erected their church as a molder might do, reproducing forms and shapes whose structures they did not comprehend. For example, the pendentives which support the domes of St. Front are faced with courses of stones set in corbels whose beds are horizontal and not perpendicular to the curve of their arch. If these do not fall inwards, it is because they are held by mortar, and adhere to the masonry, which gives them their concave form. Such a building is only an imitation of other existing forms, of whose

geometrical reason its builders had no understanding. The pointed arch, however, was the direct development of the efforts of the Romanesque builders to build permanently with the materials they had at their disposal.

68. The plans of the churches in western Europe differed but little from that of the Roman basilica, where the first Christian services were openly held. These services consisted at first of simple explanatory lectures to the assembled multitude, but as the faith spread they became more elaborate and complicated, until finally the priest and the laity became divided into totally different classes and changes became necessary in the arrangement of the plan to suit these advanced forms. The apse alone was at first appropriated to the use of the clergy, but subsequently the entire *dais*, or raised platform on which the altar stood, was separated for them by railings, called *chancelli*, from which is derived our modern term *chancel*.

The choir became extended in front of this, and contained two pulpits, called *ambones*, from one of which was read the Epistle, and from the other the Gospel. These changes took up so much of the previously available space that it was necessary to lengthen the nave and aisles to make room for the congregation, and thus the atrium and narthex became absorbed, while in their place appeared the elaborate porch so characteristic of the Romanesque period.

The flat wooden roof became replaced with a groined vault, or occasionally, as in France, by a cylindrical or barrel vault, and sometimes by a series of cupolas, as in the East. The plainness of the walls above the columns of the nave was relieved by a cornice, above which was inserted a number of windows. Similar but smaller windows pierced the side walls and even the apse, and over the porch, as well as in other prominent locations, were large circular or wheel windows, without moldings at first, but in later buildings richly ornamented, as shown in Fig. 58. The classic orders were gradually replaced with columns and capitals representing flowers and leaves of different kinds,

as well as human and animal heads, treated with great boldness and freedom. Between the years 1175 and 1220, Romanesque architecture reached its fullest development.

The eastern art and eastern forms were widely adopted

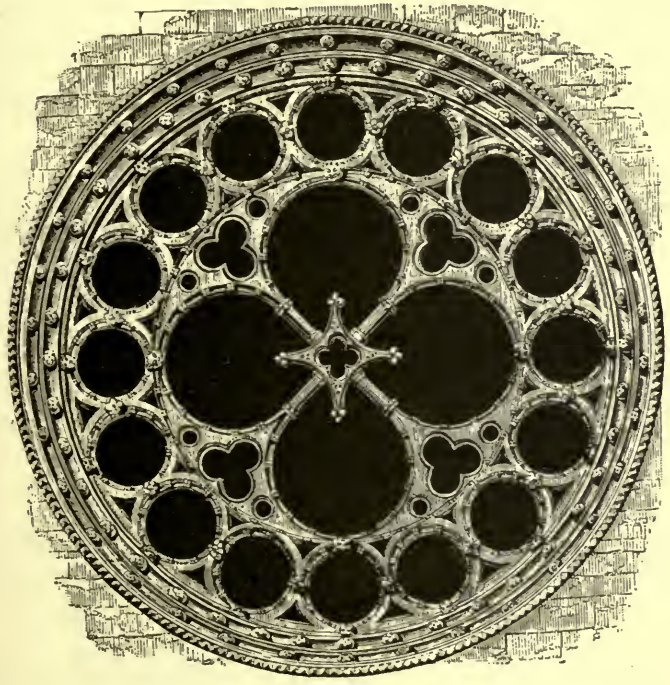


FIG. 58.

by the western architects, and the Roman arch was abandoned for the pointed and foliated arch, while clustered columns and richly carved capitals expressed a change of feeling and abandonment of all classic traditions that ended in the birth of the Gothic style.

THE GOTHIC STYLE.

69. The term **Gothic,** at first applied in derision by the architects of the Renaissance period, is now accepted as the name of the style of architecture that flourished in western

Europe from the middle of the twelfth to the end of the fourteenth century. It varied under local influence in different countries, but its distinguishing characteristics were everywhere the same. Long vertical lines and high pointed gables superseded entirely the horizontal cornice and long low pediment, while the introduction of the spire, buttress, pointed arch, and clustered column opened a new field for decoration and sculpture impossible in classic art. Each of these changes was the result of a structural necessity, and each had a meaning and purpose of its own.

The variations in the Gothic style, which existed in different parts of Europe, were due partly to geographical location and partly to traditions. The style was never perfectly developed in Italy and southern France as the numerous classic monuments and the extensive maritime relations with Rome and Byzantium prevented an independent progress in the new direction. In Yorkshire, England, however, there was a steady progressive development uninfluenced by any classic tradition, and unrestrained by scarcity of desired building material. In northern France and in Germany the style maintained an independent development, but was influenced more or less in France by the close proximity of England, and in Germany by the lack of stone with which to build.

70. English Gothic architecture may be divided into three distinct periods; namely, the *Early English*, from 1175 to 1272 A. D.; the *Decorated*, from 1272 to 1377; and the *Perpendicular*, from 1377 to 1483; each period being about one hundred years in extent, though the transition from one style to the next succeeding was so gradual that no exact dividing date can be set.

The **Early English style** includes the transition from the Romanesque to the Gothic, and the earliest structures were French in their origin, but thoroughly English in their development. The round arch of the Romanesque gave way to the pointed arch of the Gothic style, and the window openings became longer and narrower than their Romanesque

antecedents. For this reason it was necessary, in order to secure adequate light and ventilation, that they should be arranged in groups of two, three, or even occasionally four together, and the walls on the inside of the building were splayed, so as to combine the group in one window on the inside, as shown in Fig. 59, while on the exterior they were treated as individual openings, as shown in Fig. 60. The

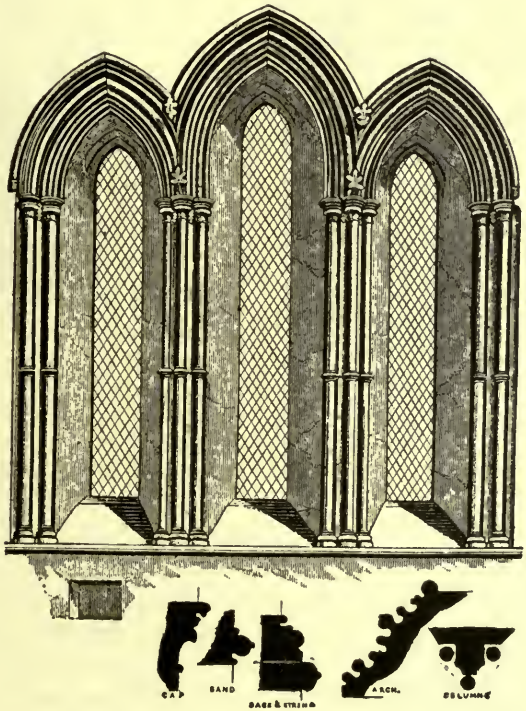


FIG. 59.

intersections of the splayed jambs were finished with small round columns, which supported a group of moldings over the pointed window head, as shown in Fig. 59. When three windows were thus grouped, the middle one was usually longer than the other two, but in a group of two they were both the same size, and included under one arched dripstone,

as shown in Fig. 61, while the wall under the point of the arch, was pierced by a trefoil or quarterfoil opening, as shown. Three windows were grouped under one dripstone as the style

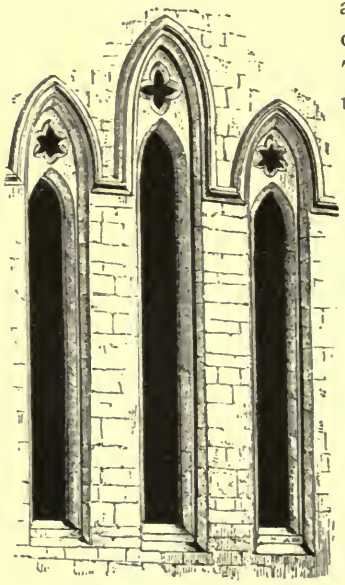


FIG. 60.

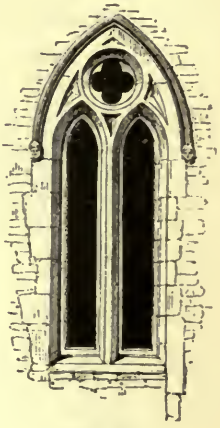


FIG. 61.

advanced, and their mullions, or dividing bars, were split and carried to the top of the opening in curved lines parallel to the opposite sides of the arch, as shown in Fig. 62, thus giving the appearance both within and without of a single opening divided by bars.

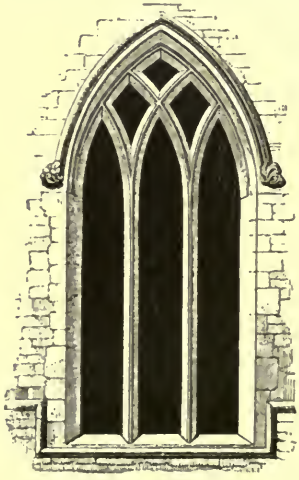


FIG. 62.

This treatment of the window heads is called **tracery**, and the structural system of the window tracery furnishes a key by which each period of English Gothic architecture can be readily determined. The above examples are characteristic of the Early English period, particularly Figs. 59 and 60, which are called *plate tracery*,

where the openings are cut through a flat wall surface, in distinction from *bar tracery*, where the openings are outlined by bars or split mullions, as in Fig. 62. Bar tracery made its appearance towards the end of the Early English period and shows the tendency of the style toward the Decorated period which followed.

71. Early English door openings were first arched with the round arch of Romanesque origin. Later they became pointed, and were often divided in the middle by a column and treated like a pair of lancet windows, such as are shown in Fig. 61. Square-headed doors were occasionally used, but their corners were corbeled out, as shown in Fig. 63, while a wide chamfer was cut from the angles of the jambs. Occasionally a door with corbeled corners was arched over with a round arch, giving the head the form of a trefoil, but examples of these are rare, and confined to distinct localities.

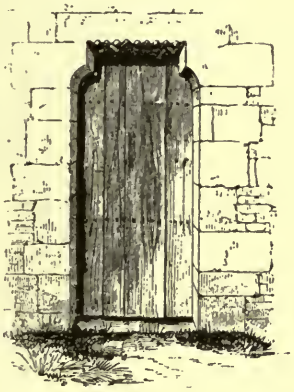


FIG. 63.

72. We now come to that detail which is most characteristic of all Gothic construction; i. e., the vault. Early English vaults are bold in their structural design; spanning large openings without apparent assistance, and are simple and devoid of ornament, except the molded ribs, which are carved on the angles of the groins, and the foliated *boss* which marks the intersection of the ribs. Fig. 64 shows a portion of the vaulting in the cathedral at Salisbury, England, the plain treatment of which is characteristic of this period. These large vaults, though simple in their apparent construction, required complicated buttressing to maintain them in place. The buttresses projected very boldly from the wall, as shown at *g* in Fig. 57, but were stepped off toward the top, as shown at *f*, and the great flying buttresses

d, which in the Romanesque style were always concealed under the roof of the side aisles, are now carried high above the roof to receive thrust of the large vaults over the nave. The buttresses were seldom ornamented and the character of the whole period is more expressive of thorough, systematic

FIG. 64.

construction than it is of progressive development of ornament. The Early English architects built for permanency, and it was the succeeding period which inherited this almost perfect construction, and devoted its energies to the beautifying of it.

73. The **Decorated style** is distinguished by wider windows used singly, and divided by narrow mullions, or bars, instead of the narrow windows arranged in groups, as in the previous style. The tracery in the tops of these windows takes the forms of circles, trefoils, quarterfoils, and other geometrical shapes, which are not arranged perpendicularly, each over the one below, but are usually so placed that each form occupies a position above and between two similar forms

beneath. Thus, it will be observed in Fig. 65 that the window is divided into three **days**, or openings, by narrow mullions which divide and close each day in a pointed arch. Two foliated triangles then rest on the points of these arches,

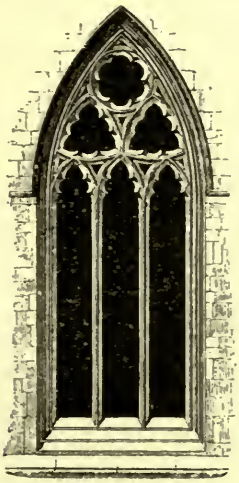


FIG. 65.

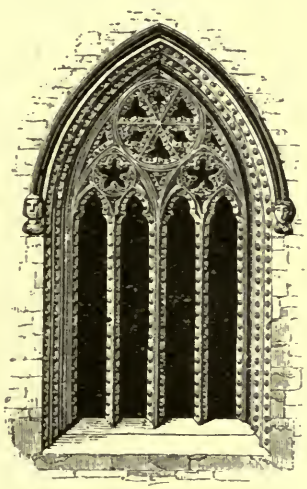


FIG. 66.

and a circle is poised between the vertices of the triangles. A vertical line drawn through the center of any one of these forms would not cut the center of the next below—a feature which is peculiar to the Decorated period. The jambs and mullions of the windows were richly ornamented, particularly with a device known as the *ball flower*, which is shown used to great excess in Fig. 66. This ornament is characteristic of the Decorated period, its more sparing application being shown in Fig. 67.

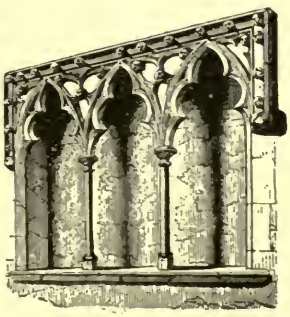


FIG. 67.

Circular, or **rose**, windows reappear in this style, though the details of their tracery are vastly more complicated than in the Romanesque. Circular subdivisions, as shown in Fig. 58, never

exist in rose windows of this period, except occasionally at the center, and then only as starting points for straight

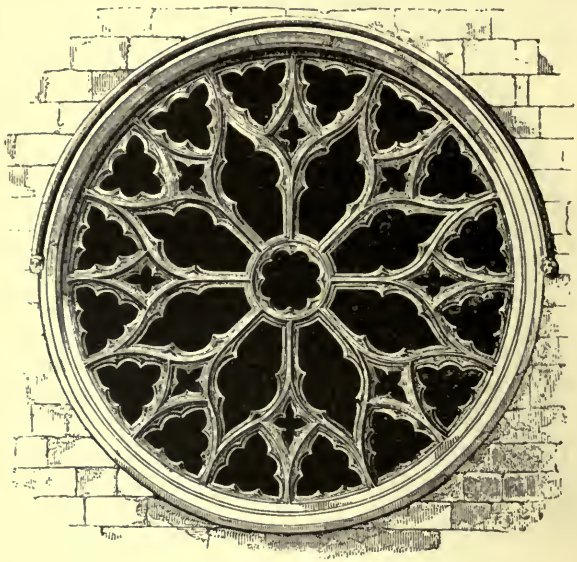


FIG. 68.

radial bars, which, like the mullions of the vertical windows, split near their outer extremities and enclose several eccentric geometrical forms, as shown in Fig. 68. The doorways were large and richly ornamented, and were usually protected by arched dripstones, supported on small carved heads, usually portraying the king and the bishop, or other prominent prelates, as shown in Fig. 69. Small niches arranged as seats, called **sedilia**, were introduced into blank portions of the wall during this period. These were sometimes divided by small columns connected with foliated

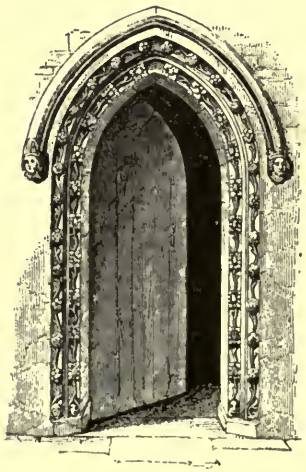


FIG. 69.

arches, as shown in Fig. 67. The vaults became more complicated than in the Early English period, and instead of confining the ribs to the angles of the groins, extra ribs were introduced and spread over the surfaces of the vaults to increase the decorative effect, as shown in Fig. 70. The columns supporting these vaults were no longer single piers, but were arranged in groups, or clusters, carrying the lines of the vault ribs down to the plinths, or bases, on which the shafts rested.

The exterior features, such as buttresses and flying buttresses, became much more ornate, as shown in Fig. 71.

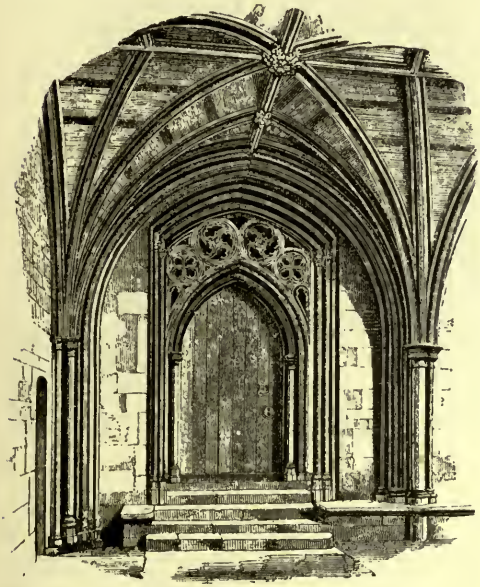


FIG. 70.

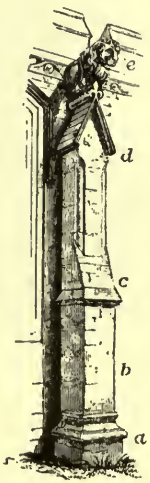


FIG. 71.

The former were usually divided so as to consist of a pedestal *a*, which receded to a smaller section at *b*, to which the front sloped back as at *c*. The top of the buttresses were sometimes gabled as at *d*, and a *gargoyle*, or ornamental spout, delivered the water which accumulated behind the parapet *e*.

74. In the **Perpendicular style** the tracery becomes more and more complex, and differs from the former type by its tendency to assume the perpendicular form. The mullions are carried straight to the window head, as shown in Fig. 72, which is a view of the west front of St. George's Chapel at Windsor. The tracery is composed almost entirely of vertical elements. This perpendicular feeling

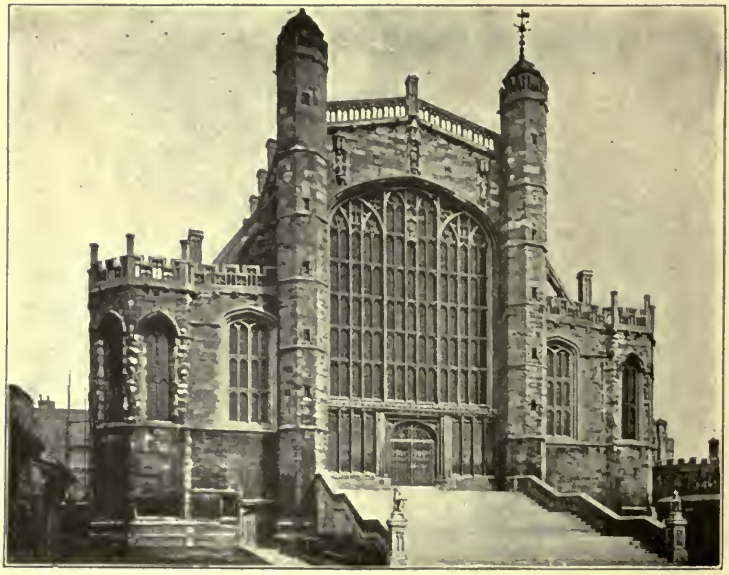


FIG. 72.

showed itself not only in the traceries, but also in the general design of the entire building. Long, narrow panels ornamented the buttresses, as shown in Fig. 73, while the windows in the side walls were treated simply as openings in the panel work. The porches were unusually elaborate at this time, and highly enriched with pinnacles, buttresses, panel work, etc., as shown in Fig. 74. The ogee and crocketed gable are the distinguishing features of the **Tudor period,** which was the latest phase of the Perpendicular style, and is so called from the royal house of Tudor, then

reigning. The vaulting in this period reaches its most complex form, the interlacing lines, or ribs, completely covering the soffit of the vault. In Fig. 75 is shown a portion of the vaulting of the Henry VII Chapel in Westminster Abbey, a most elaborate example of *fan tracery*, so called from the

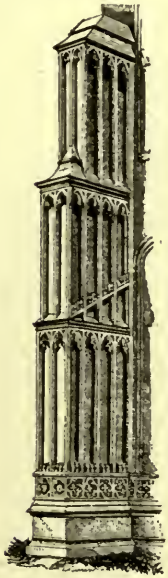


FIG. 73.

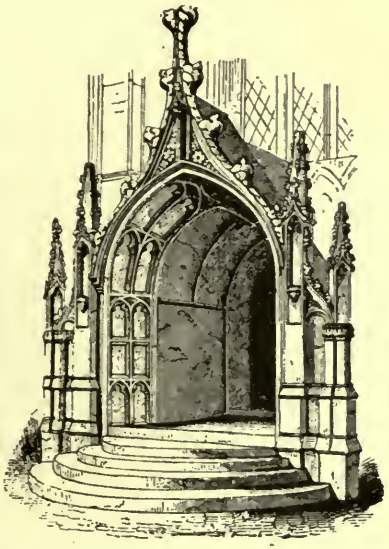


FIG. 74.

fact that the ribs rise from the springing of the vault and from intermediate pendants, and diverge regularly like the radial ribs of a fan.

75. After the Tudor period the Gothic loses its purity. We have seen it develop from the simple Romanesque forms to the complex designs at the end of the Perpendicular period, when it reached its limit, and a reaction naturally set in. From this time we find Gothic structures tainted with classic and other foreign detail. This occurred, not only in Great Britain, but also on the Continent, where the change took the name of *Renaissance*, but in England it was first called the *Elizabethan style*, or *late Tudor*. This

incongruous mixture of Gothic and classic features continued to the middle of the eighteenth century, when Gothic was revived in England, and has been the prevailing style down to the present day.

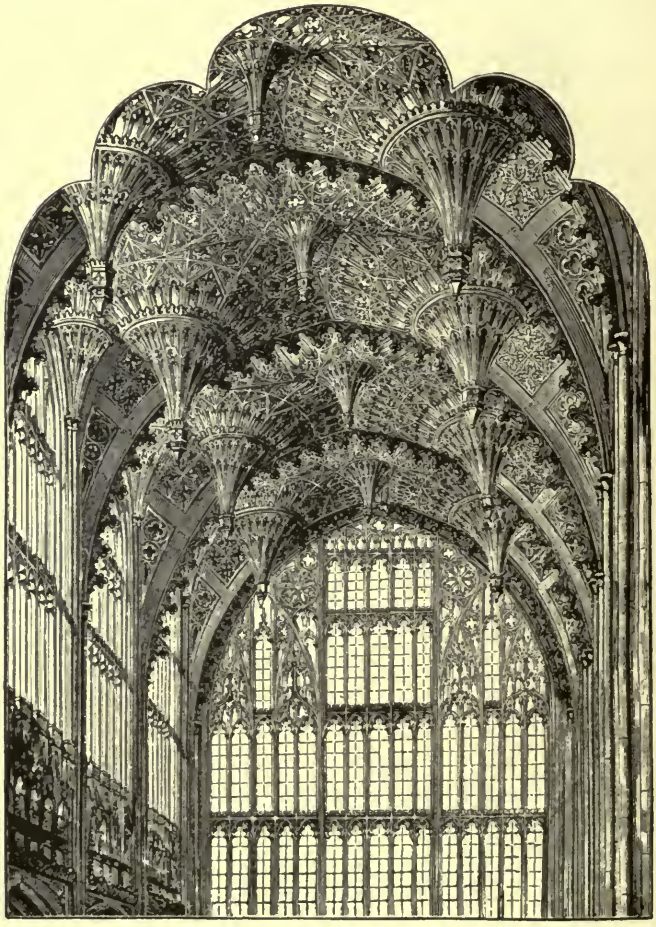


FIG. 75.

76. The peculiarity of all English cathedrals compared with those on the Continent is their extraordinary length in proportion to their width. The length of pagan temples

was generally twice the width, while the length of Continental cathedrals was four times the width, but the English churches exceeded even these, their length being from five to six times their average width.

Winchester Cathedral is 556 feet in length and is 85 feet in width. It was remodeled in the tenth century and again in the eleventh, and is now the longest and finest of English cathedrals. A plan of the cathedral is shown in Fig. 76, the dotted lines on the floor area representing the lines of the groins of the vaulting overhead. One of the most valuable buildings for the study of English Gothic architecture is Canterbury Cathedral, as it shows work during the entire period of transition from Romanesque to Gothic.

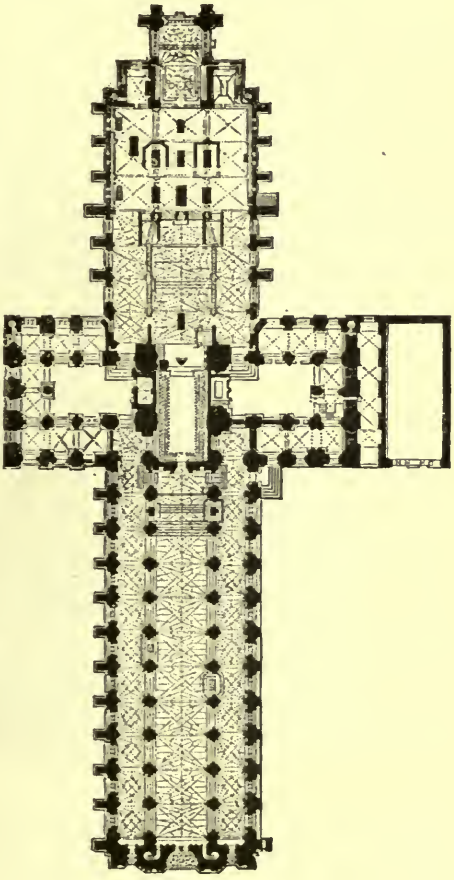


FIG. 76.

Westminster Abbey, founded in the eleventh century, Fig. 77, illustrates the transition from the Early English to the Decorated style. It is another most important structure to the architectural student. Its extreme length, including the Henry VII Chapel, the interior of which is shown in

Fig. 75, is 530 feet. The height of the western towers is 225 feet. The Henry VII Chapel was completed in 1509, covering the site of the original lady chapel, and contains the body of the king whose name it bears. It is the finest piece of work in the Tudor style in Great Britain, and is

Fig. 77.

at once one of the stateliest and daintiest monuments of Europe, both as a chapel and sepulcher. In Westminster Abbey on Christmas day, 1066, William the Conqueror was crowned first king of England, and each of his successors, including Queen Victoria, received coronation in the same place.

77. In France, the progress of Gothic architecture was much affected by the political divisions of the country. The southern part was populated by a Romanesque people,

whose architecture was very slightly affected by their barbarian conquerors, while the northern portion was occupied by the Franks in such numbers as to materially alter the status of the race. So, in a straight line from south to north, the architecture gradually advanced from simple Romanesque on the Mediterranean to Flamboyant French Gothic on the English Channel. Neighboring provinces also differed greatly from one another. Normandy, for instance, in the twelfth century was an English province, and the difference in style between this and other districts was greater than between Normandy and England. In a considerable part of southern France, the Byzantine influence was introduced by a colony of Greek or Byzantine merchants. In Perigueux, the Church of St. Front was distinctly a Byzantine edifice, modeled after St. Mark's, at Venice. Many other Byzantine churches existed in this province, as well as in Aquitania.

78. The **Early French style** differs in many respects from the Early English, although agreeing with it in general character. The French churches are much larger and higher than those in Great Britain, and the tendency of the architects seemed to be in the direction of making each new nave higher than its predecessor, until every idea of proportion in other parts was sacrificed to it. Immense flying buttresses became necessary to support these lofty roof vaults, but the towers at the west entrance and at each end of the transept were very little higher than the ridge of the roof.

79. The period of transition from Romanesque to Early French occurred in the reign of Philip II (1179 to 1223), although it began during the reign of Louis VII, under Abbe Suger. In England the change took place under Henry II (1154 to 1189), and the new style was fully established under Richard I (1190 to 1200). In both countries the examples built during the transitional period are so numerous that it is difficult to say which has the advantage. The French churches have the greater height, and in them

is made a more general use of vaulting. The arrangement of numerous chapels in the apse afforded an excellent field for the display of ingenious and complicated vaulting. The Cathedral of Notre Dame at Paris, founded in 1163, is of this period. The front elevation is shown in Fig. 78, and it

FIG. 78.

is of interest to know that its erection was contemporaneous with Lincoln Cathedral in England.

80. Early French columns are usually plain and round, with capitals of a classic character, somewhat resembling the Corinthian or Composite, while the arches have a plain square soffit with a chamfer on the angle. The windows are

either plain lancets or consist of two lights under one arch with the head frequently pierced by a circular opening, at first plain, but afterwards foliated. As the style advanced, the thickness of the space between the two lancets gradually diminishes until the later examples appear in fine bar tracery. French windows have fewer moldings and much less splay than their English neighbors, but their doorways are much larger and finer, and are often richly sculptured with full-

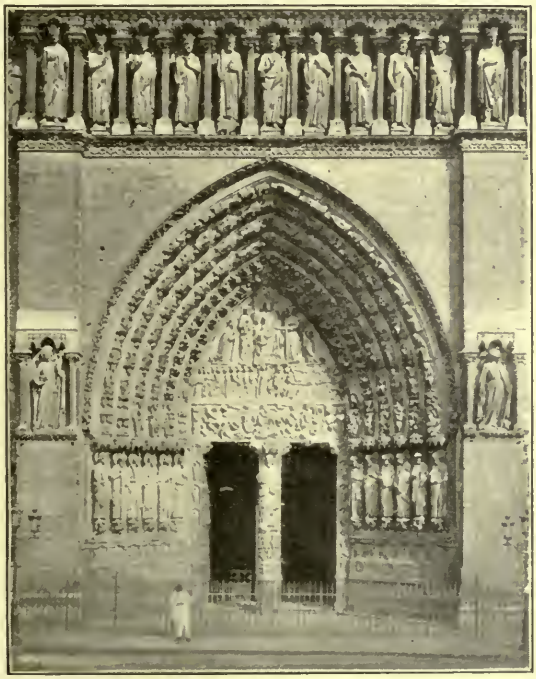


FIG. 79.

length human figures, as shown in Fig. 79, which is the central door of the Church of Notre Dame.

81. The Decorated style in France does not differ materially from the same style in England. There are few large buildings of this style in France, the greater part of the cathedrals having been rebuilt in the thirteenth century or

continued in the same style throughout the fourteenth. The tracery shows less variety than in England, consisting almost exclusively of trefoils and quarterfoils until the advent of the Flamboyant style.

82. The **Flamboyant style** developed from the Decorated in France much more rapidly than did the Perpendicular in England; it also differs very materially from the latter, and has few features in common with it, though obviously contemporaneous. The variety of Flamboyant work found in different provinces is almost endless. The window traceries frequently take the form of a large *fleur de lis*—the French term for flower of the lily—or sometimes a heart, or the heraldic device of the family that caused the building to be erected. The windows are the principal guide and key to the style, and are distinguished by their flame-like tracery, from which the term Flamboyant is derived.

In the French Gothic style the crockets are larger and more separated than in English work, and *battlements*, or indented parapets, are never used at all. The Flamboyant style continued throughout the fifteenth and sixteenth and part of the seventeenth centuries, becoming gradually more mixed with the revived classic details, until superseded by the Renaissance.

83. Gothic architecture in Italy is unique. Its character is entirely different from the style as we find it in northern Europe, and the plans, groupings, and treatment of the details all show the influence of the surrounding classic monuments and ancient Roman traditions. In northern Europe Gothic architecture was developed through centuries of church building. In Italy we find but one cathedral of importance in the Gothic style. In England the plans were irregular and unrestrained; the elevations showed abundance of detail and ornament, but the lines were vertical, and horizontal string-courses, cornices, etc., where they did occur, were broken or stopped against vertical buttress lines in order to prevent them from undue prominence. Columns

were used exclusively as an internal feature; window openings were large and numerous, and were usually pointed and richly traceried.

Contrary to all this we find the Italian Gothic plans very regular (usually rectangular), owing to the influence of the ancient Roman buildings. The elevations are most elaborately detailed, but without any attempt to preserve the predominance of vertical lines, or to prevent the prominence of horizontal members. Columns and colonnades appear as exterior features everywhere, and the windows are small and regularly grouped.

84. One of the earliest Gothic buildings in Italy is the Palace Vecchio at Florence, shown in Fig. 80. This build-

FIG. 80.

ing, erected in 1298 A. D., was originally the town hall, or seat, of the city government, and consequently is built in a severe and fortress-like style. It is especially remarkable for its tower which rises 308 feet above the pave, and overhangs the wall of the building nearly 6 feet, being supported

by the powerfully corbeled cornice. The windows, it will be observed, are small, regularly spaced, and though possessing foliated heads, are entirely devoid of tracery.

In Venice, however, the window details are richly carved and show beautiful examples of both plate and bar tracery.

85. The Ducal Palace, shown in Fig. 81, is the principal building in the Venetian Gothic style, though it has been submitted to many alterations since it was built. The two-storied arcade dates from 1354, and originally stood out from the main edifice, which was widened in the fifteenth century,

FIG. 81.

and the upper walls of white and black marble, in a checker-work design, were erected over the columns. These arcades are beautiful designs, combining massive strength and grace in a manner unseen in any of the northern and western Gothic edifices. The columns have no bases, and in the first story are somewhat clumsy, but the upper arcade and tracery are as delicate and graceful a piece of work as can be found in the country. The proportions of the building as a whole are

not pleasing, however; the top story appears heavy and out of place with the delicate carving beneath, while the subdivision of the facades into three horizontal elements so nearly the same width, is not in accordance with the rules of good architectural composition.

86. The Foscari Palace, shown in Fig. 82, is a much smaller building, but the grouping of the parts are so admirable that a most pleasing effect is obtained. The double

FIG. 82.

arcade and balconies of white marble in the center, flanked on either side by the darker-colored brickwork, produces a most pleasing contrast, as well as a feeling of repose in the parts, by the careful grouping of the windows, and the judicious exposure of plain wall surface.

87. A still smaller building, but withal a masterpiece of the Venetian style, is the little Palace of Contarini Fasan,

also known as the House of Desdemona, shown in Fig. 83. This little structure, by the proportioning, grouping, and

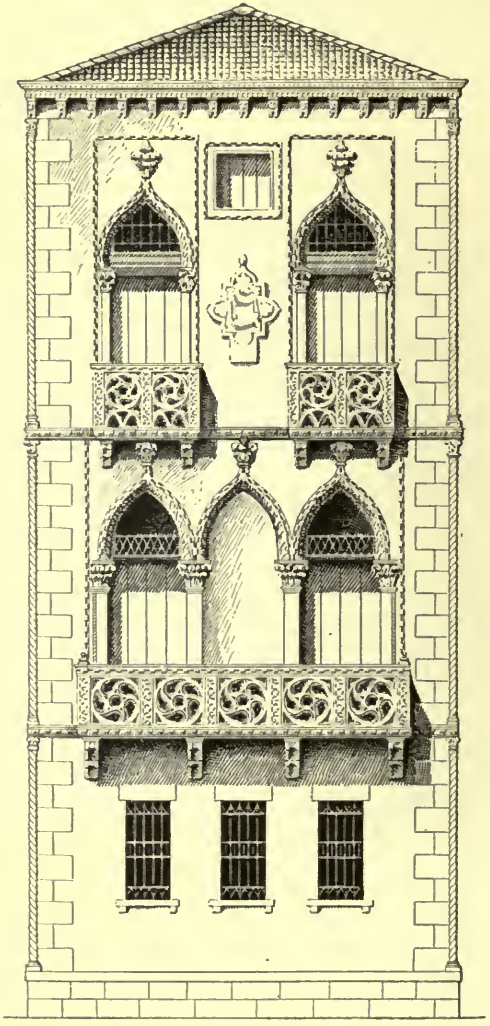


Fig. 83.

treatment of its details, expresses more clearly than any other building in the style, the wide adaptability of the Venetian

Gothic to residence work, and at the same time shows the wide field for elaboration and carving presented by the numerous loggias and balconies.

88. The cathedral at Milan, though erected in 1440, cannot be properly considered as an Italian Gothic structure. Built entirely of white marble, gorgeous in its decorations, and more lavish in the sculpture of its spires and pinnacles than any other building in the world, it fails to command the admiration it deserves on account of the monotony of its detail and the lack of purity of its style. Designed by a German architect, and erected under the supervision of an Italian artist, it possesses none of the national characteristics peculiar to Italian Gothic, while the classic tendency of its details detracts from the meritorious work of its German designer. It is the second largest of the medieval cathedrals, however, and a beautiful structure, though its architecture fails to show any progression in the Italian style.

89. *German Gothic* is similar, though inferior, to the French style, but possesses many original characteristics. The traceries and details are thicker and heavier than the French, and the plans of the cathedrals are shorter and wider in proportion. In eastern Prussia and other localities where stone was scarce, many Gothic edifices were erected in brick, which gave a character to the style not found elsewhere.

DOMESTIC ARCHITECTURE.

90. A false impression prevailing in the minds of the majority of students is that Gothic architecture was confined entirely to churches and other ecclesiastical edifices; the fact is that this style pervaded every building that was erected in western Europe during the thirteenth and fourteenth centuries. The castles and residences of the nobility formed an important part of the architecture of the middle ages, and established details and peculiarities of plan which have been retained in a more or less modified form down to the present day.

Though these castles were primarily military posts, they were at the same time the official residence of the lord or baron who governed the territory, and while they were built in accordance with the medieval ideas of defense, their planning is expressive of the feudal relation of the vassal to his lord, who, while he exacted the former's services, also maintained him, under the same necessity he felt of sheltering and feeding his cattle—in order to fit him for work.

91. In general plan, the feudal castle consisted of a *keep*, or central tower, surrounded by a *moat*, or ditch filled with water, on each side of which was a large enclosure, or courtyard, known as the inner and the outer *bailey*, the entrance to the keep being from the former. The stables, barns, granaries, etc. were generally in the outer bailey, but clustered around the keep, which was the final place of refuge in case of an assault. In its lower stories the keep contained storerooms for provisions and dungeons for prisoners, and in the upper stories lived the lord and his family, especially in time of danger.

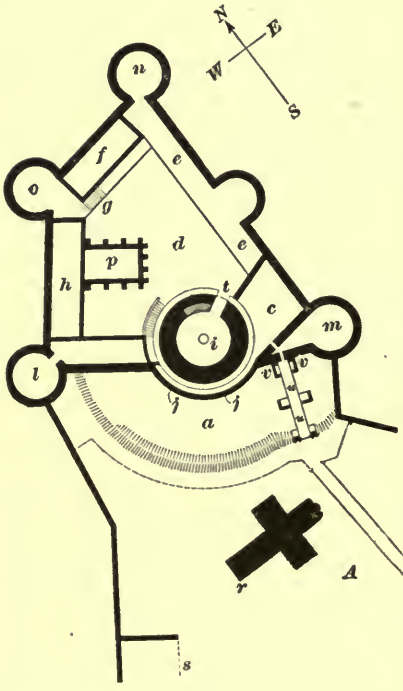


FIG. 84.

In Fig. 84 is shown a plan of the Castle of Coucy, near Laon, France, which was built in the thirteenth century and is typical of the style of residence of the nobleman of that period. Fig. 85 shows the general appearance of the exterior of the castle, and the letters of reference

thereon mark the same details as are indicated by similar letters on the plan.

At *A* is shown a portion of the outer bailey, containing the chapel *r*, the stables *s*, and other buildings not here shown.

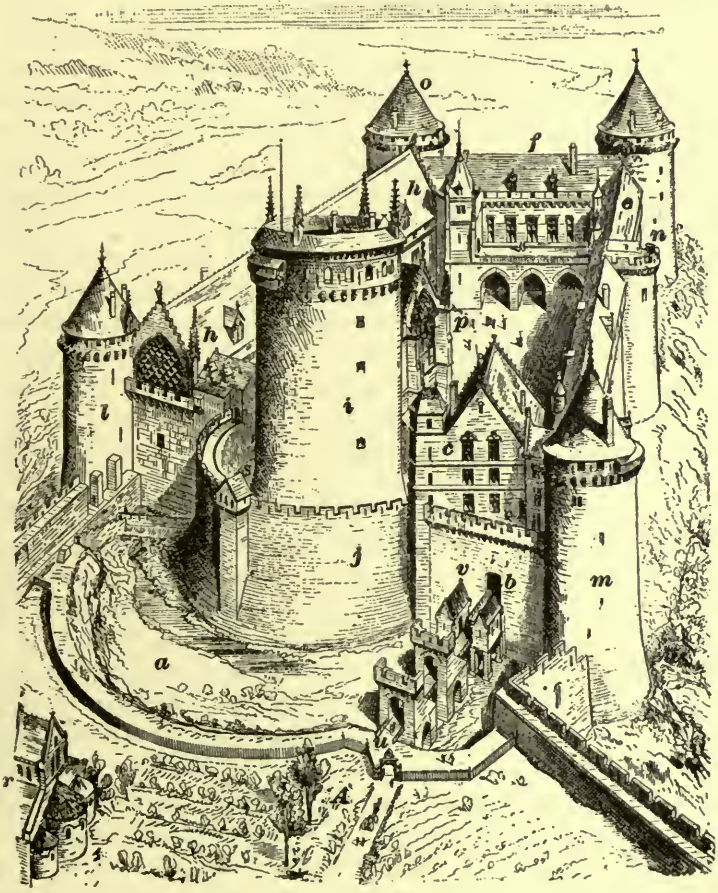


FIG. 85.

The entrance to the castle proper, shown at *b* in Fig. 85, is approached over two drawbridges *u*, *u*, which are defended by the guard rooms *v* and a double portcullis, or vertical sliding gate, within. These drawbridges cross the moat, or *foss*, *a*, which in time of danger is filled with water to prevent

an attacking party from undermining the walls. Beyond the entrance *b* is a vaulted guard room *c* with sleeping apartments above, and beyond the guard room is the inner bailey *d*, bounded on the east by the heavy curtain wall, which is surmounted by the covered buildings *e*, erected for the shelter of men who are placed there to defend it during attack. On the north side *f*, where the ground slopes off so suddenly as to make it an unlikely point of attack, are located the family apartments, reached by a stairway shown in the plan at *g*.

The apartment *h* on the west side is the great hall, which was the principal living room of the house, where all meals were served, all business transacted, and where such amusements and pastimes as the age afforded were indulged in. At *i* is the keep, or *donjon*, entirely surrounded by a water-filled ditch and in front by the curtain wall *j*; and at *t* is its entrance over a drawbridge similar to those at *u*. The keep was the most important structure of the entire castle, being the final place of refuge in time of siege, and the last point of defense, when all other towers have been surrendered. At the Castle of Coucy this keep was 108 feet in diameter and its walls were 34 feet in thickness at the base. Its height of over 180 feet was divided into three stories, each of which was a vaulted hall or chamber with twelve ribs, or *groins*, converging to an opening or eye in the center. The uppermost of these chambers was by far the largest, as the walls were not so thick as at the base, and around the inside was built a broad gallery, 10 feet above the floor. In this immense apartment fifteen hundred soldiers could be assembled, and an officer standing in the center could give his orders, which were heard by every man. Around the outside of the keep, at the gallery level, supported on projecting corbels, was a parapet wall, the floor behind which was pierced between the supporting corbels with openings, through which the besieged could shoot or pour boiling oil, molten lead, etc. upon the besiegers below. These openings, called *machicolations*, were a characteristic detail of the towers of every feudal residence.

Down in the basement of this massive structure were not only storerooms sufficient for provisions to last a thousand men over a year, but also dungeons for the confinement of prisoners taken in war, who were in most instances left to starve in darkness and filth, without the shadow of a chance of ever seeing daylight again.

Back of the keep is a chapel *p* exclusively for the use of the liege lord and his family, but opening into the great hall *h*, which, as said before, was practically the only living room in the house. The family apartments contained but few sleeping rooms, and the noble and his family, with their servants, retainers, and visitors, were all accommodated in this one room, where all household and public duties were carried on. The smaller towers, *l*, *m*, *n*, and *o*, were built entirely for purposes of defense, and in time of peace were practically unused.

92. Having studied the details and arrangement of the residence of a medieval nobleman, let us now consider the system of government under which these people lived, that we may better comprehend the gradual evolution of society from the darkness of the middle ages, and discover from whence many of the forms and devices of modern house planning are derived.

These castles were usually located on the top of a hill, with the ground sloping away from all sides but one, and on this one side was the principal entrance. On the lower slopes of the hill was the town, or cité, as it was called, where the vassals of the nobleman grew their vines and plied their trades; but they held their various pieces of land subject to the rule and under the tenure or lease of the lord of the castle. They were compelled to pay him a large portion of their produce, and to serve him in the defense of his castle at any time he should be at war with any of his neighbors. The lord, in his turn, held his estate, or *fief*, subject to some higher political power, as a duke, or even the king, and his failure to comply with the demands of his superior would usually bring down a war upon his shoulders

and necessitate the calling of all of his vassals to the defense of the castle. These petty wars were very frequent, and generally ended in the almost total destruction of the castle, or in its entire subjugation, and the passing of the fief into the hands of the enemy.

In case the lord of the castle was successful and retained his estate, his vassals were then rewarded with silver or gold; but, in either case, they were compelled to give one day's work out of every five or seven towards the repair of the damaged castle walls. Each time this rebuilding became necessary, some more or less important change would be made in the construction, owing to experience gained at each war; consequently, the architecture of these castles was rapidly progressive, until the use of gunpowder in warfare rendered the castle system of defense practically useless. The castle was none the less the earliest form of nobleman's residence, and, therefore, the prototype of the modern mansion. Long after fortified residences became obsolete, the castellated form was used even for a city

FIG. 86.

residence, and as late as the middle of the fifteenth century we see many prominent features of both plan and elevation that remind us of the days of the feudal system.

The house of Jacques Cœur, a wealthy French merchant, Fig. 86, was built about the year 1443, and we can readily

see in its court the original idea of the inner bailey, while its towers and turrets are suggestive of the fortifications of less peaceful times. The interior, however, is decidedly different from the arrangement of the feudal castle, though it is the direct descendant of it.

Education of the people brought about a desire for privacy, and the great hall *h*, Fig. 84, was reduced in size by having a room cut off from it, where the sire and his family could retire after their meals had been eaten. This room was called the *withdrawing room*, and is the parent of our modern *drawing room* and *parlor*. The lord still received his guests and attended to his public affairs in the *hall*, however, but it was separate from the room where he took his meals, which now became known as the *dining hall*. In the fourteenth century, owing to the increased desire for privacy, the highest development of the hall was attained, and on the introduction of the withdrawing room, we see the germ of the modern gentleman's residence, which, in its highest development, is an expression of the wants, inclinations, and habits of the refined society of today, as was the keep and castle of the feudal society of the middle ages. The Gothic hall was planned with a vestibule separated from the hall itself by a heavy-paneled and carved-oak partition, or screen, as it was called. Over this was a minstrels' gallery, where musicians and vocalists played or sang for the entertainment of the family or guests, while at the farther end of the room was the *dais*, or raised platform, on which the master and his principal guests were seated. A large bay window fitted with seats gave external as well as internal emphasis to this end of the hall.

In the fifteenth century, the fireplace, instead of being placed in the center of the apartment, as it was in the earlier days, was removed to the side wall, and the sleeping apartments were much improved and increased in privacy; and in the sixteenth century the common dining hall decreased in importance, and the lord and his family dined separate from his servants.

The development of the house plan from this time forth

was directly due to the advancement in the education of the people during the celebrated period called the Renaissance. Studying classics and classic forms, they learned to admire the ancient ornament, and applied it, at first, to the details of their Gothic castles and manor houses. As time progressed they applied not only the ancient ornament to their residences, but they imitated the plans and shapes of classic tombs and temples in the edifices which were intended as domestic structures.

RENAISSANCE ARCHITECTURE.

INTRODUCTION.

93. Renaissance, meaning literally rebirth, is the name applied to that period of European history when humanity emerged from the ignorance of the dark ages, to the light of reason and common sense. It is a period marked by education and enlightenment, as distinguished from the ages of superstitious ignorance which preceded. Previous to this time few persons could either read or write, even among the nobility, such accomplishments being confined almost entirely to the clergy. But about the middle of the fifteenth century, a desire for learning spread among the people, and the study of classic literature brought to light, not only the knowledge of classic forms and customs, but also the superior education of the upper classes of the people during the advancement of imperial Rome. The fifteenth century students, then, naturally inferred that the designs executed by such a literary and artistic people as the Romans, must necessarily be far superior to anything of which their contemporaneous architects were capable, and a sudden revolt from Gothic to classic forms took place throughout the Continent; and attempts at imitation of classic buildings were immediately started, regardless of the purpose or place, or the convenience of the construction to the later requirements of buildings.

The Renaissance architect knew nothing of the history

of architecture leading up to these classic forms—knew nothing of the structural necessities which lay at the origin of the architectural orders in Greece, nor of the structural differences and lack of appreciative taste which caused the modification of those orders in Rome; but he accepted the classic designs as beautiful, simply because classic literature so declared them, and the people who wrote that literature must in his estimation have been well enough educated to know. With this blind misconception of facts, the Renaissance architect proceeded to enclose his Gothic plan with four walls, whose elevations showed an abundance of classic detail of the true meaning of which the designer was entirely ignorant.

Heretofore, in both classic and Gothic architecture, all ornament on a building had been a part of the structural system; a column, an entablature, or a pediment had existed in its original design because the construction required its services; but now, the architect adopted these details and planted them on and in his building to support imaginary constructions which the edifice itself in no way required.

The architectural principle, therefore, was at first manifestly incorrect, but, notwithstanding this fact, Renaissance designs were many of them very beautiful in appearance, and displayed great ingenuity in the fitting of the classic forms to their new places; but the history of architecture, as a historical development of constructive principles, ceased with the advent of this style.

94. Renaissance architecture naturally originated in Italy, where the classic monuments were most numerous; from there it spread to France, and finally reached England. Its progress in each of these countries was inversely as the progress of Gothic had been. In Italy, where Gothic had never secured an unrestricted development, the Renaissance was adopted and developed without any apparent opposition. It first appeared in the early part of the fifteenth century, and reached the zenith of its development before the close of the century. In France it did not appear until the close of

the fifteenth century, and was first combined with Gothic details; it progressed steadily to the beginning of the seventeenth century, but then began to decline. In England, the Renaissance secured no foothold until the middle of the sixteenth century, and its progress and development was slow, as the country had been so thoroughly imbued with Gothic taste that the new forms met with but little favor.

The political condition of Europe at this time had a marked influence upon the architecture, as well as had the changes which were taking place in the Christian church. New nations had been formed and civilized since the days of classic Rome, and consequently the royal palaces and villas of the nobility formed a new class of building upon which the architects could lavish the classic details. The Christian church had become split, one part adhering to the old forms and traditions, and the other part insisting upon reforms, both of the government and the doctrines of the church.

Church building therefore received a setback, as the unity and power of the great organization which had made the Gothic cathedrals possible, was now temporarily broken, and all classes of people became more worldly in their tastes and less devoted to their religious duties.

ITALIAN RENAISSANCE.

95. The architects of the Renaissance occupied themselves more with form than with construction, and their buildings show but few problems in construction involving any great difficulty. Although the new style began with the construction of a colossal dome over the cathedral of Florence, and culminated in the stupendous Church of St. Peter at Rome, it was preeminently an architecture of palaces, of villas, of facades, and of decorative display, rather than of ecclesiastical works.

96. The Duomo, Fig. 87, was the cathedral of Florence, Italy, and though erected during the Gothic period, it was not finished until the year 1464, when Filippo Brunelleschi

completed the dome over the immense octagon, 143 feet in diameter.

This work, started in 1420, was the first use of the dome as an external feature, outside of the districts of Byzantine

Fig. 87.

art, and though in itself it was not an imitation of Roman forms, it was classic in spirit by its vastness and its simplicity of outline, and was made possible only through Brunelleschi's studies of Roman design and construction.

97. The Riccardi Palace in Florence, completed in the year 1430, was the first residence erected in the Renaissance style. It is an imposing structure with a rectangular facade, two stories in height, standing over a massive basement, and crowned with a classic cornice of excessive proportions. The windows were mullioned as in the Gothic style, but were widely spaced with intervening piers of rusticated ashlar masonry. The general exterior appearance of these palaces is somewhat fortress-like and forbidding, but they were nearly always built around an interior courtyard, which was

light and cheerful, and which was surrounded by a vaulted colonnade on three and sometimes on four sides. The origin of these interior courts may be found in the atrium of the early basilicas in Rome, where precisely the same arrangement existed in front of the entrances. They afforded shady open-air resting places within the palaces, and added much to the comforts of the buildings as residences, besides materially enhancing their architectural effect.

The Pitti Palace, Fig. 88, designed by Brunelleschi, embodies the same ideas upon a much larger scale, but lacks the grace of an adequate cornice. Here the wall surface is broken by heavy rusticated pilasters in two stories, while the

FIG. 88.

windows on the garden wings are small and unobtrusive. The windows on the court, however, are exceedingly wide, occupying, with their flanking columns and pilasters, the full space between the rusticated orders.

98. In Fig. 89 is shown a view of the Strozzi Palace, erected in 1490, which may be taken as a typical example of the Florentine style of Renaissance design. The first story, it will be observed, has small windows protected by heavy iron gratings, while in the center of the facade is a broad entrance door, which was guarded by a heavy iron gate. This fortress-like arrangement is due to the fact that these palaces were in part castle and part residence. During the frequent local wars of this period, it was often necessary for the nobility to retire within their palaces and defend them

against the attack of an invading army. The exterior was therefore made very formidable, not only in appearance, but also in fact, while the upper stories of the interior and the elevations on the court present an appearance much more in accordance with the idea of domestic life and household comforts. The broad entrance door in the center of the facade was a carriage entrance, or driveway, into the court, and from this court, under the shade of the surrounding arcade, several doorways gave access to different parts of the palace. The upper stories of the building, though executed in the same style of heavy rustic ashlar, were provided with more

FIG. 89.

liberal arched window openings, which were divided by a central columnar mullion and two smaller arches extending from the mullion to the jamb on each side. The space between the tops of the smaller openings, and the soffit of the arch over the main opening, was sometimes pierced by a simple system of plate tracery, as in the Gothic designs, but as the style advanced this and other details of Gothic origin were abandoned, and the style approached nearer and nearer to the old classic system of design. The heavy cornice crowning the building is designed with modillions or consoles, as in the Roman-Corinthian order, and is proportioned to the height of the building, in the same ratio as though

the entire substructure was a Corinthian column and pedestal.

99. The Florentine school, or system, of Renaissance design, is expressive of formidable dignity and structural severity on the exterior, but displays the most delicate appreciation of refinement and luxury in the treatment of the court elevations, and the arrangement of the interior plan. Large rooms, high ceilings, and broad unbroken wall surfaces, richly decorated with frescoes and arabesque designs, are characteristic in all the Italian schools of Renaissance design, but in Florence particularly this interior treatment is to be seen at its best, on account of the omission of columns and pilasters, as the principle feature of interior decoration.

100. The effect of the Renaissance movement upon the architecture of Venice was manifestly different from the Florentine style, owing largely to the geographical differences between the two cities. Venice being more distant from Roman influence, and having possessed a certain amount of Gothic influence, was ready to treat the Roman forms with more freedom and delicacy, while Florence, situated in the center of the ancient district of Etruscan art, naturally inherited some of the tendency to heavy and massive construction.

In the Venetian school of the Renaissance, columns and pilasters are used freely in all designs, the windows are grouped near the center, leaving comparatively solid boundaries to the facade. The facades are flat, having no great projections, in consequence of the buildings being situated along the sides of canals, instead of on streets and therefore necessitating a straight front on the water. The rustication of the walls seen in the Florentine school is comparatively unknown in Venice, and the facades usually have a separate cornice marking the division between each two stories instead of the heavy cornice crowning the whole structure, as at Florence. Balconies are numerous and the details of the facade are regularly disposed and symmetrically grouped.

101. The Vendramini Palace, Fig. 90, was built in 1481, and is one of the earliest buildings in Italy where engaged columns are used to divide the facade. The lines of its composition are vigorous and stately, and its broad arched and mullioned windows, separated by engaged columns, established a type of large windowed and vigorously modeled facades, which later architecture developed but never sur-

FIG. 90.

passed. The treatment of the arched heads of the windows is suggestive of Gothic influence, though the mullions and other columns are derived directly from Roman models. The grouping of the windows towards the center of the building, and leaving a flanking wall mass on each side is a typical Venetian feature which is also traceable in some of the Gothic designs, as shown in Fig. 83.

102. Among the architects conspicuous in the Venetian school of Renaissance, were San Micheli and Andrea Palladio, the former through his designs for such works as military fortifications, city gates, etc.; though his palaces at Verona and Venice were also much admired, and are interesting as showing the wide difference of ideas conceived by two men contemporaneously studying the classic models and

converting their details to modern uses. San Micheli adopted the Roman orders quite as readily as did Palladio, but he used them in only one story at a time, as shown by the front elevation of the Grimani Palace at Venice. Here each story of the building was treated as a separate composition, with independent columns, or pilasters, and a proportionate cornice. The openings were made very wide, and the well separated columns were thereby made to appear as though they really carried some of the superstructure and were needed in the building, while the cornice crowning the structure was proportioned to the height of the whole, and tended to unify the composition. Palladio's designs usually made use of the orders in gigantic proportions, reaching from the basement to the cornice of the structure in single shafts, between which the window openings were simple rectangular wall piercings.

103. The characteristics of the Venetian school are: elaborate exterior designs, in which the Roman orders are extensively used; wide openings and a tendency towards elaboration and detail, rather than towards structural simplicity and purely architectural effect.

104. As the Renaissance advanced, it was inevitable that the constant study of Roman architecture should lead to a closer imitation of classic details and eventually to an absolute copying of antique designs. Towards the close of the fifteenth century, correctness in the rendering of the ancient Roman forms came to be considered the chief of architectural virtues, and the *orders* became the principal resource of the architect. Externally the orders were freely used in the decoration of doors and windows, and in the court arcades of the palaces. Frames around these openings, and pediments over them were extremely elaborate, and cornices and moldings were profiled with the utmost care, while the balustrade was elaborated into a most intricate and ornate device, but always on strictly classic lines. This period started in Rome with the erection of St. Peter's Church and continued till a complete transformation was effected throughout the city.

105. Bramante, the first architect of St. Peter's, proposed to combine, in one design, the great dome over the Pantheon with the vaulting of the Temple of Peace, and thereby erect a building which should exceed in size, elaboration, and structural complexity, any ecclesiastical edifice ever erected. The foundation for this great church was laid by Pope Julius II, on the eighteenth day of April, 1506. Bramante died seven years later, but the building was continued at irregular intervals, under different architects until the year 1546, when Michael Angelo was assigned to the work by Pope Paul III. Michael Angelo completed the building with the exception of the dome, which was finished after his death in 1564, by Fontana. Michael Angelo left a plaster model of the dome from which it was completed according to his design. It is 140 feet in diameter and poised on the top of a circular colonnade; it rises to a height of 405 feet above the church floor. As left by Michael Angelo at the time of his death, St. Peter's Church was as harmonious a design as existed in the Renaissance style, but in 1606 the nave was lengthened, under orders of Pope Paul V, and the proportions were destroyed, as the dome became hidden on close approach, and the facade was tasteless and insignificant. The magnificent *atrium*, surrounded by the double colonnade, which was added by Bernini, in 1667, gives dignity to the approach, but does not compensate for the weakness of the design of the main facade, Fig. 91.

St. Peter's is the largest church in existence. The central aisle, nearly 600 feet long and 83 feet wide, with its splendid paneled and gilded vault, together with the central space under the majestic dome, combines to form an architectural conception unsurpassed in majesty, simplicity, and effectiveness. This interior, Fig. 92, is, however, lacking in the sobriety of color that is befitting so stately a design. Elaborate carvings, brilliant frescoes, and expanses of burnished gold, are more suggestive of the interior of a pagan temple than of a Christian basilica, but reveal the decline in taste towards the end of this great period, of a style which, borne on a tidal wave of popularity, swept over Europe and exhausted

FIG. 91.

itself in the effort to constantly approach a false ideal. At the advent of the Renaissance the architects were compelled to exercise much ingenuity, in order to combine the classic and Gothic forms, but with advanced study their ingenuity

FIG. 92.

declined and the practice of a servile copying of classic forms resulted.

St. Peter's Church is noble in its proportions, majestic in its conception, and gorgeous in its decorations, but at the same time its coloring is gaudy, its design is servile, and its style inappropriate as a monument to the Christian faith.

106. The Church of St. John Lateran, in Rome by Galilei, erected in 1734, Fig. 93, shows on its exterior the application of the orders in excessive proportions, as first practised by Palladio at Vicenza. The design is a very powerful one, however, combining, as it does, a colossal order with two smaller orders in superposed loggias. The composition is marred by the excessive size of the statues which crown it, but, taken all together, this facade may be considered as one

of the masterpieces of the later Renaissance. The portico is 33 feet deep and 196 feet long, and the open loggia above it is one of the finest in Rome. In this portico we have the legacy of one of the chief characteristics of the earliest Christian churches; namely, the *narthex*. During the transition from the Romanesque to the Gothic period, the narthex

Fig. 93.

disappeared from most church plans entirely; but in Rome the churches of St. Peter, St. Paul, and St. John Lateran (originally built during the reign of Constantine) adhered very closely to their early plans in spite of the numerous changes and alterations which succeeding periods imposed.

107. The palaces of Rome are classed among the finest in Europe. Their design is not as heavy as those of Florence, nor as delicate as those of Venice, but the architects of the Roman Renaissance period have, by means of a diligent study of the ancient monuments, reproduced in the palatial residences of their aristocrats the most imposing features of the tombs and temples of their pagan ancestors. Roman palaces were usually of great size and built around large courts, with arcades of classic model in two or three stories. On the street front, the structures were crowned with a rich cornice proportioned to the height of the building, in the relation of entablature and column. The orders themselves

were used but rarely on the exterior, and effect was obtained by careful proportioning of the stories, and in the form and distribution of the openings. The first story was given up to suites of sumptuous apartments, elaborate halls, reception rooms, etc., the walls and ceilings of which were decorated with magnificent frescoes by the greatest painters of the day, and groups of statuary and bas-reliefs were disposed in the courts and vestibules, and in the wall niches of the principal rooms of these princely dwellings.

108. The finest of the palaces, the Farnese, built by Sangallo in 1530, is shown in Fig. 94. It is an immense building, 260 feet by 192 feet, whose rectangular plan and

FIG. 94.

simple elevations are given dignity and impressiveness by the careful proportioning and arrangement of the window openings, and by the treatment of their details. The lower story is very plain, consisting merely of a row of square-

headed openings in a plain masonry wall surface, which is relieved at the center by an immense carriage entrance to the beautiful court within. The windows in the upper stories are flanked each side by three-quarter columns, which support a pediment over each opening, and the whole structure is surmounted with a magnificent cornice, designed by Michael Angelo, which is worthy of its position on the finest palace in Rome.

The interior court of the Farnese palace is a magnificent enclosure over 125 feet square, and surrounded on four sides by a deep colonnade, over which the second story of the palace extends. Like all the Renaissance palaces, the court elevations of the Farnese are considerably more elaborate than the exterior fronts, but the simple treatment of the entire design places it in the lead as one of the most successful buildings in the Renaissance style.

In Fig. 95 is shown the court of the Borghese Palace, which is typical of this detail of Renaissance design. The

FIG. 95.

arcades rest upon clustered granite columns, of the Doric and Ionic orders, in the first and second stories respectively, and the whole is proportioned with much delicacy and refinement.

109. When these palaces were built on the outskirts of the city, or beyond the municipal limits entirely, the courts were sometimes dispensed with, and great care was given to the laying out of a park or garden on one side of the palace, which should afford a pleasing outlook from the principal rooms.

In Fig. 96 is shown the garden front of the Villa Medici, erected in 1540 by Lippi. The entrance, with its central arched and flanking trabeated openings, and supporting

FIG. 96.

columns, is a typical detail of the Roman school of the Renaissance, which was much copied in many subsequent buildings erected in other countries. The walls of this facade are tastefully decorated with numerous bas-reliefs of allegorical subjects, and are indented with niches for the reception of statues and busts. The window openings are few and comparatively small as they face the southwest, and the rays of the tropical sun are not desired within. This lack of windows is the cause of the surface decoration of the walls proper and the consequent originality of the design.

110. Two architects prominent in the Italian school of Renaissance, were Giacomo Barozzi de Vignola, who built

many of the finest palaces in Rome, and Andrea Palladio, whose works in and around Venice have already been alluded to. These men each wrote a treatise on the "Five Orders of Architecture," which was accepted by the contemporary and subsequent architects as a standard of authority. Vignola's book is particularly exhaustive on the subject, and goes into the minutest details relative to the proper proportions which should exist between different members of an order in a building, or between the members of two different orders, and is used as a standard of reference even at the present day.

FRENCH RENAISSANCE.

111. Renaissance architecture in France was at first greatly influenced by the declining Gothic art. The French artisans, who for years had been carving Gothic ornaments and details, could not change their style of working so completely that the classic designs were not somewhat tainted with Gothic feeling, and as the architects themselves were trying to combine a classic ornamentation and a Gothic construction, the resulting edifices in the early French Renaissance exhibit an individuality possessed by no other class of buildings in Europe.

This early Renaissance was marked by the free and liberal use of the architectural orders, and is consequently much more artistic than the later work. That is, the Roman orders were altered to suit a Gothic construction (and well fitted their places when so altered), instead of the system which prevailed later in the style of making the plan, construction, and even convenience of the buildings entirely subservient to the prolific use of classic details and combinations. Gothic architecture had always made use of small columns in places where the load to be supported was small, and in consequence the Renaissance buildings first erected in France have the small details characteristic of the preceding style—widely different from the works of Palladio in Italy, where the orders were used in gigantic proportions, to ornament a meaningless and false construction. In France, the

high-pointed gables and the numerous pinnacles of the old style were retained after the advent of the Renaissance, thereby presenting a new field for classic detail never before known. Castles which had existed in previous years only in the Gothic style, now assumed a new aspect exceedingly beautiful and decidedly novel from an architectural standpoint. The plans were very similar to the old buildings, as at this time there had not been sufficient change in the general condition of society to induce an alteration of the plans of the residential buildings.

This early period of the French Renaissance is generally termed the Francis I period, and it lasted from 1483 to 1559; after which the Gothic feeling became entirely superseded, and the architecture became a servile imitation of the classic designs according to the proportions established by Vignola. This is called the Henry IV period, and lasted until 1610. The age of Louis XIV, which followed this, was typical of great exaggeration in the details of the orders and the ornaments applied to the buildings. In the effort to invent an improved style while they were still tied to the Italian school, there resulted only the introduction of a meaningless lot of ornamental forms and grotesquely designed capitals which are characteristically described as *rococo*, a French term meaning frivolous.

112. The most interesting monuments of the French Renaissance are the châteaux. These constituted the country residences of the kings and their royal relatives. The chateaux are somewhat similar in character to the villas of Italy, but were situated farther away from the cities, and were used more as *rural* retreats than were the Italian villas. A characteristic that distinguishes the French from the Italian Renaissance, as explained in Art. **90,** was that the earliest royal residences were in the form of a feudal castle; and when the invention of gunpowder rendered the castellar system of defense ineffectual, these residences began to assume a less forbidding appearance and a more hospitable outlook.

Large mullioned windows, flanked by classic pilasters, pierced the outer walls, while conical and high-peaked roofs covered the towers and main buildings. Richly ornamented dormer-windows and pilastered chimneys broke the roof slopes, while the buttresses and vaulting of the Gothic system were still retained. Thus we find the honest straightforward system of castellar construction emerging from its crudeness, and bedecking itself with the refinements and frivolities of the approaching Renaissance. Along the River Loire are a number of these châteaux, many of which were erected or altered during the reign of Louis XII, while others were remodeled by his successor, Francis I. The châteaux along the Loire Valley therefore afford the student most excellent monuments from which to study the French Renaissance throughout its entire development.

113. The Château of St. Agil, shown in Fig. 97, still possesses, each side of the drawbridge entrance, the massive towers of feudal days, and the spreading foundations where its walls sloped off to the defending moat. Somber-looking, stone-bound loopholes, still exist in the sides of the original brick towers; but, on the front, overlooking the approach, these relics of feudalism have been replaced by liberal window openings, flanked with paneled pilasters, and divided by molded mullions and transomed bars. The stone buttresses each side of the doorway, originally built to receive the thrust of the vault, have outlived their structural usefulness, and are now deeply niched on the angles to receive a piece of statuary. The parapet walls are roofed over, the machicolations are closed up, and though the supporting corbels still exist, they are richly molded now to form a part of the cornice work under the upper construction of the building. Through the slopes of the roof appear richly carved dormers, whose flanking pilasters on the towers are carried down to the corbel course, while through the parapet wall over the entrance a broad mullioned window expresses the fact that comfort and hospitality within have replaced the barbarous scheming which took place there a

century back. In short, the stern feudal castle of the dark

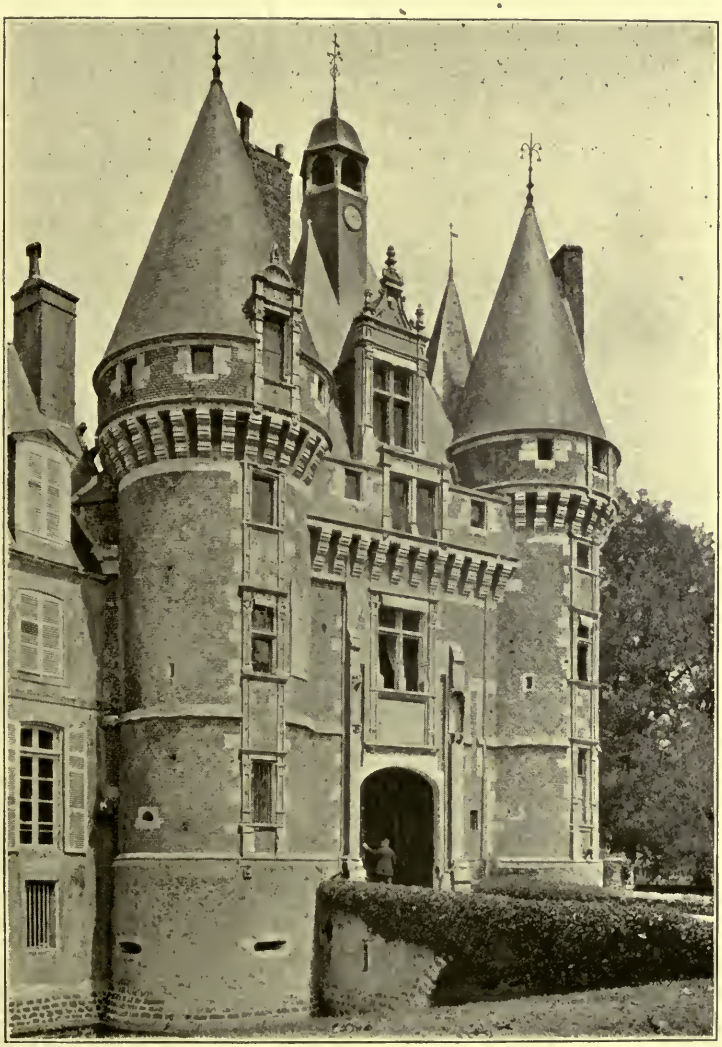


Fig. 97.

ages has matured in the picturesque château of the Renaissance.

114. Though long before the beginning of the reign of Francis I, the feudal system had disappeared from France, yet the architecture of the day adhered to the details which were characteristic of the feudal castle. The Château Azay-le-Rideau, Fig. 98, though erected in the sixteenth century, still retains the corner turrets and the corbel parapet of its feudal ancestor; but what a change of details—windows whose breadth nearly equals their height; gabled dormers which are masterpieces of the sculptor's skill; paneled

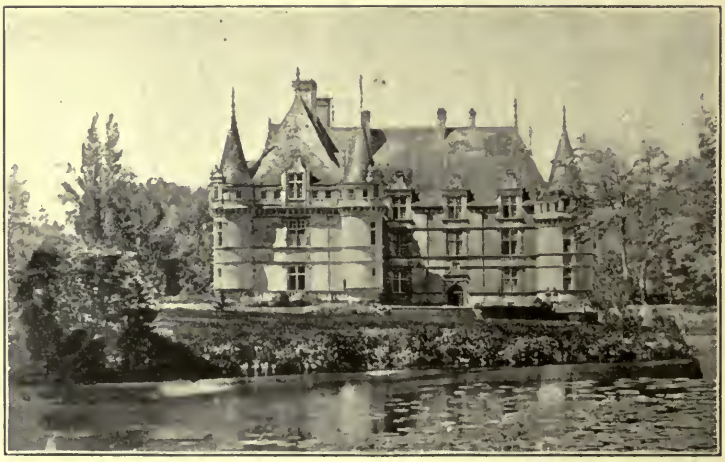


FIG. 98.

chimneys as ornate as the pilaster-flanked doors and windows, and with all this extravagance of detail, contrasted with broad surfaces of absolutely plain wall to prevent monotony.

Nothing could be more graceful than these sixteenth-century châteaux; they combine the structural dignity of the Gothic with the taste and refinement of the Renaissance period, without expressing either one to excess. Every detail of Azay-le-Rideau betokens the refinement of aristocratic taste, while its plan and system of construction are in no way hampered in order that the details may be expressed. As the Renaissance became more advanced, the value of

these points was overlooked, and the structural principles and ornamental details became separate and distinct considerations, the latter often serving the purpose of hiding the character of the former, thereby really expressing an architectural untruth.

115. The Château Chenonceau, though built about the same time as Azay-le-Rideau, is expressive of a more advanced period of the Renaissance than is the latter. On the north front, shown in Fig. 99, the towers will be observed flanking the facade, but of much smaller diameter than

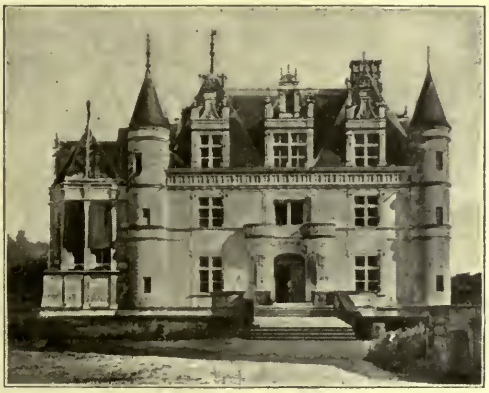


FIG. 99.

their feudal prototypes. The flanking bartizans, which in feudal ages guarded the central entrance, are now replaced with two corbeled balconies supported on pilasters. The dormers are large and richly ornate, the center one being designed to include two attic stories in order to emphasize its increase in size. The corbel course and parapet wall have here entirely disappeared, though across the eave line a light cornice is carried upon a row of small consoles, over a paneled frieze, which reaches down to the window heads. The openings in the towers are comparatively small, and possess no ornamental features whatever, the towers themselves having shrunken to the grade of a mere detail of the design,

whereas in former periods they were the main adjuncts of the castle. This, however, shows an advancement in design. When towers and turrets were most essential features to the defense of the castle, they were also the most prominent parts of its exterior design; but now, when they no longer play an important part in the welfare of the structure, they are retained only as a relic of the past, and retired to make room for the display of windows and balconies, which are more characteristic of the advanced period.

116. The largest, and in some respects the most important, of these country residences of royalty, is the Château de Blois, a plan of which is shown in Fig. 100. In this

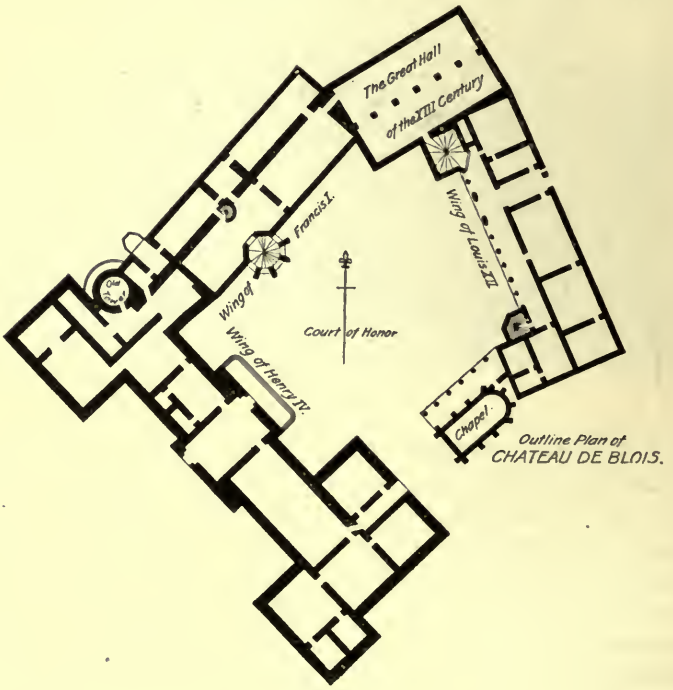


FIG. 100.

structure, as it exists at the present day, are brought together the expressions characteristic of each successive period of the French Renaissance.

The plan of the château consists of three wings so disposed as to enclose a *court of honor* in the form of a distorted quadrangle, this irregularity being a most conspicuous and characteristic bequest, left to the new structure by the old medieval castle on whose lines the present edifice is erected.

The northeast side was built by Louis XII at the end of

FIG. 101.

the fifteenth century; the northwest side was completed by Francis I in the middle of the sixteenth century; and the southwest side is the work of Gaston of Orleans in the beginning of the seventeenth century. The wing of Louis XII, shown in Fig. 101, is built of black and red brick combined with light stone. Its roof is high, of purple slate, with

beautifully studied dormers, the details of which are more suggestive of Gothic than classic models, as are also the moldings of the windows below. But the open portico in the first story, with its flat, three-centered arches, supported on alternate round and square shafts, all richly decorated, are characteristic of the new school of design, and make, with the five great mullioned windows above, a regular and well disciplined design. The archway which leads through the wing to the exterior of the château is emphasized by being somewhat wider than the others, and flanked by heavier piers. On the outside, this entrance to the court of honor is flanked by rich engaged shafts under a conventional Gothic niche, wherein, against an elaborate background of fleur de lis, rides King Louis XII upon his charger, Fig. 102. To the right of the entrance, a little sally port gives the pedestrian access to the passage, over which, in bas-relief, is carved a porcupine and knotted cord, which, with the conventional fleur de lis, is emblematic of Louis XII and Anne of Austria, his queen.

FIG. 102.

117. We will now turn to the wing of Francis I, on the northwest side of the court, Fig. 103. This was erected but fifty years after the wing of Louis XII was completed, but the difference in style is manifest even to the most casual observer. The artists of the sixteenth century, hurried along by the swift current of those fifty years of wonderful intellectual regeneration, seemed to understand even better than their successors that the Romans had not used the orders as elements of construction, as the Greeks did, but as decorative details having no essential relation to the construction whatever. They seemed to know by instinct that there was no law, moral or artistic, why they should not take

those Roman orders and details, and use them in any way they chose, structural or nonstructural, so long as their use

FIG. 103.

suited the purpose to which they were applied. Thus, a study of this period of architecture shows that the French builders accepted not the conventional restrictions of the

classic formulas, but their essential spirit as an organized scheme of ornament.

The court facade at Blois shows that the lessons in classic styles given by the great Italian masters, who were entertained at the court like princes, were accepted by the French architects with respect and intelligence, but were not learned by rote. The lessons were accepted as an influence, but not as a law. The windows in the basement have but little vertical coincidence with those of the stories above, showing an irregularity of fenestration most certainly due to Gothic influences. The flanking pilasters of these basement windows support a string-course, which forms a line of demarcation between the inferior order and that of the more important system of pilasters, which, while they decorate the two stories above, have no direct relation to the scheme of division beneath. At the eave line, the old Gothic cornice of defense is converted into a cornice of most delicate beauty. The coarse corbels which supported the parapet are replaced by elegant modillions, borrowed from the Corinthian order, and the black machicolations between them, through which ancient defenders of the castle poured missiles and boiling oil, became a series of delicately molded arches, the soffits of which each enshrined a shell. Below this cornice a row of dentils and minor moldings suggested a study of the classic orders, while above it an elaborate balustrade was carved with the crowned letters F and C, for Francis and Claude, the king and queen.

118. The greatest artistic effort of this facade, however, was the octagonal staircase, which is considered one of the masterpieces of the sixteenth century, though it is at the same time another example of the audacious independence of the French architects of this period. It has no architectural relation to the wall surface from which it protrudes, except that its four great free-standing buttresses support a cornice and balustrade, which are a continuation of those on the wall. These supporting buttresses, whose axial lines in plan radiate from a common central point,

are divided into two sections by horizontal moldings, marking the level of the third-story floor, while they stand on molded bases, and are topped with carved capitals of a composite character. A niche on the lower part of the face of each of these piers, contains a beautifully carved female figure under a canopy of most elaborate fancies of Gothic imagination, expressed in the terms of the new period of art. With these features the horizontal elements of the stair tower cease; every other detail ramps with the ascent of the stairs. Richly carved balconies on these sloping lines are carried from pier to pier, the balustrades being divided into panels, each alternate one of which has carved in high relief the crowned F, or the crowned Salamander, both emblematic of Francis I. The design of all these features is free and romantic, yet when we compare this wing with the neighboring one built but fifty years before by Louis XII, we cannot but consider them new and fresh, articulate and grammatical expressions of Renaissance feeling, with none of the timidity which generally characterizes the first trial of a new style.

119. In the southwest wing, Fig. 104, which was designed by François Mansart, for Gaston of Orleans, a brother of Henry IV, we see the tendency of the age not to adapt the classic detail to the construction, but to literally copy the classic orders, and to decorate every opening and angle with some form of classic ornament, regardless of the convenience of plan, or propriety of the detail. As the architects became more learned they lost their fearlessness and independence, and instead of simply borrowing ideas from classic models, they appropriated the whole design. The Roman orders of architecture, according to Vignola, were loyally reproduced by Mansart in the southwest wing at Blois, presenting a contrast to the wing of Francis I that is full of historic meaning.

Mansart constructed the first story in the Doric order, the second story in the Ionic order, and the third story in the Corinthian order, precisely as the works of Vignola

dictated. The window heads, pediments, and arch imposts were all intended to be strictly Roman, and a suggestion

Fig. 104.

that any part of the composition was of French origin, would have been considered an insult to the designer. The roof, however, was an invention of the architect; existing through necessity, but designed to slope back, as if hiding

itself behind the aristocratic classic detail. No high roofs existed in the ancient monuments, and it was impossible for the architects of the seventeenth century to introduce to prominence any detail, no matter how necessary, that had not its origin in classic Rome.

120. The most important work of the Francis I period, was rebuilding the Palais Louvre, in Paris. The old Gothic fortified palace had always been the principal residence of the kings, but it had become so unsuited to the requirements of the age, that it was torn down in 1546 and entirely rebuilt in the new style, from plans prepared by two architects—Serlio, an Italian, and Pierre Lescot, a Frenchman. The Louvre consists of a quadrangular court 394 feet square, surrounded on four sides by galleries, two of which extend westward till they meet the Palais Tuileries. The east wing, or gallery, of the Louvre is 548 feet long and 90 feet high, and contains the celebrated colonnade, subsequently designed by Perrault. The south side faces the river Seine, and is 2,250 feet long. In the middle of each facade facing the quadrangular court, there is a pavilion rising above an archway over each of which are constructed niches, which were afterwards embellished with statues. The height is divided into three stories, the divisions of which are emphasized by pilasters in the Corinthian and Composite orders. The orders, however, were not used in great prominence, and the ornament and sculpture were appropriate and refined.

121. The transition from the style of Francis I to the period of Henry IV, is marked by a tendency of the designs towards the characteristics of the late Italian school. The orders are now used very conspicuously, and pilasters assume extravagant proportions, as in some of Palladio's designs in Italy, while rustication in most fantastic forms disfigures the columns and archivolts. Fig. 105 shows one of the entrances of the Palais Louvre, the detail of which is typical of this period. The elaborate rustication of the columns, the carved griffins, etc. in the frieze and the crowned

H on the panels over the columns are all details which combine to stamp the design as a composition of the advanced Renaissance, when the trend of the style was towards absolute classic servilism.

The southwest wing, at Blois, belongs essentially to this period; Gaston of Orleans, its projector, having been a brother

FIG. 105.

of Henry IV. There can be little doubt that the strides towards classicism at this time were hastened by the marriage of the king Henry IV to Marie de Médicis, an Italian who introduced into the French court a taste for Italian art, literature, and customs.

122. The **Age of Louis XIV** was remarkable for its literary and artistic activity. The architecture was conspicuous by its liberal use of the orders in exterior design, while the interior decoration was light and capricious, usually to excess. Papier

maché and stucco were freely used in a fanciful style of relief ornamentation, far better suited to the decoration of a boudoir than to that of a ballroom, or hall of assembly.

In 1688 the east wing of the Louvre was completed from the designs of Claude Perrault, the court physician, whose plans were accepted in preference to those of Bernini, the celebrated architect of St. Peter's colonnade at Rome. His design consisted of a magnificent Corinthian colonnade nearly 600 feet long, standing upon a high basement of the simplest

FIG. 106.

construction, Fig. 106. This colonnade forms one of the most imposing facades in existence, but is at the same time a mere decoration, and possesses no structural relation to the building it forms a part of. It is dignified and stately and well suited to its position on the facade of the finest palace in France, but its existence is structurally as unnecessary as the papier-maché ornament on the interior walls.

To this period is also due the Hôtel des Invalides, or veterans' asylum, Fig. 107, by J. H. Mansart, a son of François Mansart. Here we see the classic orders in superposed series with Palladian regularity, while the whole is crowned with a dome, which is a masterpiece of the age.

123. French Renaissance architecture is marked by the good proportions of its parts, and the harmony and propriety of its detail. The most interesting period is undoubtedly that of Francis I, so far as studied exterior design is

FIG. 107.

concerned, but throughout its history the French Renaissance steadily advanced in the mastery of planning, and its use of pavilions, crowned by high-peaked or Mansart roofs, gave even in classic designs an individuality found in no other

country. French Renaissance is essentially an architecture of staircases, dormers, chimneys, and roofs, as well as of monumental disposition of plans—the latter being an element in which the French excel even down to the present day.

124. Let us now sum up the characteristics of the French and Italian Renaissance, comparing one with the other. In Italy, there was a direct return to classic forms, while in France there existed a period of transition where classic details were grafted on Gothic construction.

In Italy the principal buildings were erected in the cities, while in France the country châteaux formed the most numerous examples. In Italy, the narrow streets of Rome and Florence, and the straight waterways of Venice, made severe classic disposition not only appropriate, but necessary, while in France, the picturesque disposition of Gothic origin was more in keeping with the country surroundings. In Italy, the influence of ancient Rome is apparent in the purity of the classic detail, while, owing to her distance and Gothic association, France was late in duplicating the Roman forms, and even then copied them from the Italian Renaissance duplications.

A street front in the Italian cities being usually seen only from one side, the architectural features are often planted on without reference to what is on the other side, whereas in France, a château being seen on all sides, a picturesque grouping from every point must be carefully studied.

Thus we see that though the same conditions brought about the change of style in France as in Italy, the local and geographical differences caused a different line of progress in the two countries.

SPANISH RENAISSANCE.

125. Spanish Renaissance architecture was contaminated with details of Moorish origin on the south, and influences of the French flamboyant Gothic on the north. The style was not developed independently in any part of the country, and the monuments left us at the present day have been so

frequently, altered that the original details in many cases are obscured or lost.

It should be borne in mind that it was at the beginning of this period that America was discovered and explored by Spain. The long wars against the Moors had also ended with success on the side of the Spanish arms, and, puffed with pride in the importance of her extended possessions,

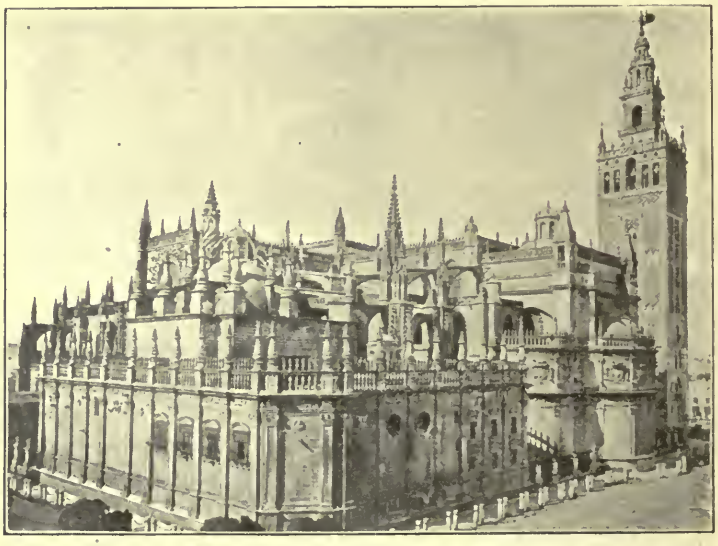


Fig. 108.

Spain lavished in her architecture a conglomeration of detail, more elaborate than artistic.

The Cathedral at Seville was altered at this time, and, as shown in Fig. 108, the classic pilaster sand superposed balustrade are attached to an originally Gothic composition, the flamboyant spires and buttresses of which stand out incongruously behind the classic facade. The upper part of the adjoining Moorish tower of the Giralda, burned in 1395, was then rebuilt in the new style, and exhibits considerable elegance and propriety of design. The decoration of the wall surfaces with intricately carved diaper work is a characteristic of the Spanish style, borrowed from the mosques

of her Moorish neighbors; while the vertical tendency of the lines and elaboration of crockets is a relic of Gothic days, inherited from the flamboyant period of France.

GERMAN RENAISSANCE.

126. The Renaissance style in Germany is chiefly remarkable for its picturesqueness of grouping, and its

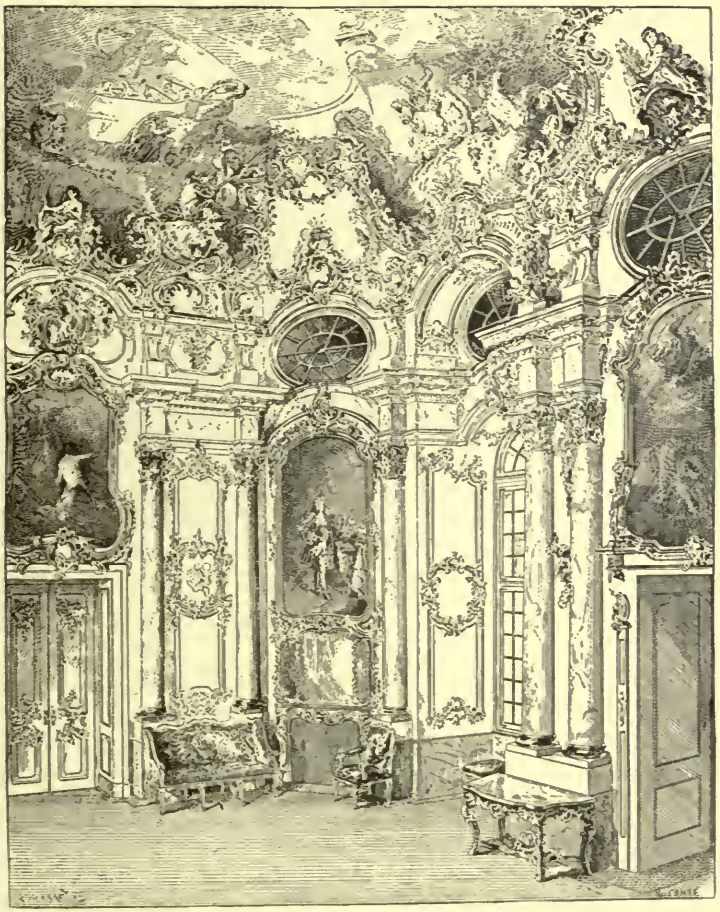


FIG. 109.

extravagance and grotesqueness of ornament, both of which characteristics are traceable to the traditions of the preceding style. Renaissance architecture was introduced into Germany from France, about the middle of the sixteenth century, when the Henry IV style was in force; hence the appearance of the early German Renaissance is marked by a coarseness of detail and crudeness of style, that grew worse as the style advanced. French architecture of the period of Henry IV was intended to be an adoption of classic models, but it fell short of its ideal, and when the German architect endeavored to reproduce a classic idea, with its French transcription as his model, the result could be none other than a mixture of style absolutely devoid of character. Moreover, the principal examples are found in the cities with details copied from French château, and the effort was so unsuccessful that, with the advent of the Classic Revival period, Germany was most prominent in the complete abandonment of her Renaissance experiments.

In some of her Renaissance designs, Germany produced very gorgeous and elaborate effects, even if she did not produce anything of great artistic merit.

The rococo ornament of the period of Louis XIV and XV was received into Germany and carried to even greater excess than in France. Fig. 109 is a view of one corner of the state drawing room in the Palace Brucksal at Baden, and shows to what extremes this frivolous detail can be carried when the decorator is unfettered by lack of either money or talented artists.

RENAISSANCE IN BELGIUM AND HOLLAND.

127. These fantastic and grotesque extremes of the German rococo naturally influenced the development of the Renaissance in Holland and Belgium, though these countries were extremely slow in accepting the principles of Renaissance art. Long after the beginning of the sixteenth century, the Flemish architects continued to employ the florid Gothic for both religious and secular structures; and, as at this time Holland was a Spanish province, there is a strong

suggestion of Moorish oddities intermingled with crude German rococo ornament.

The Church du Béguinage, Fig. 110, at Brussels, is a typical example of the Flemish style. The absence of building stone in this locality made brick construction the prevailing practice, and the appearance of the long, untapering,

Fig. 110.

Ionic, capped, brick pilasters on the facade of the Church du Béguinage, shows how ignorant the Flemish architects were of the origin and meaning of the forms they were copying. In the second story of the facade the semidetached composite columns are built up of brick, with a studied entasis, but are backed with pilasters, which the exigencies of the case required to be straight.

128. The treatment of the gables shows to what absurd extremes ornaments can be carried when not properly understood. The low pediment of Greek art was developed by

Gothic architects into the peaked gable to suit the climate of northern Europe; but here is a gable front which does not conform to the outline of the roof behind it, and which falsely declares itself to be the end of that roof. The scrolled outline of this gable, as well as the scheme of decoration around the door and windows, owe their existence to the perverted rococo of Germany; while the circular and elliptical windows are inventions of the later Renaissance in neighboring countries.

ENGLISH RENAISSANCE.

129. Great Britain was the last of the European countries to formally adopt the Renaissance style. This was due to several reasons, but particularly to the firm hold the Gothic style had upon the country. Inigo Jones, the first classical architect in Great Britain, was not born when Giacomo Barozzi de Vignola, the most prominent architect of the late Renaissance in Italy, died in 1571. St. Peter's Church was started in Rome a full century before any classic structure in England, and the Palais Tuileries in Paris had been long inhabited before any attempt to rival it was made on the other side of the English Channel.

England was on very friendly terms with both Holland and France at this time, and this friendship had a very marked influence on the first attempts at classic architecture in Great Britain. The influence of Spain during the reign of Queen Mary is also very apparent for a time, but with the ascension of Elizabeth to the throne, the period of English Renaissance is fairly started and marked by the establishment of England as a Protestant country, and the defeat and decline of Spanish power in Europe.

130. The architecture of Elizabeth's reign was essentially a transition style, corresponding in circumstances to the period of Francis I in France, but far inferior to the latter from an artistic standpoint. Elizabethan buildings, like the châteaux of France, were erected most usually in the country, as the taste of the English nobleman was for a

rural, rather than an urban, life; but many mansions were erected also in the cities, and the Elizabethan style became identified with residence construction throughout the country. This was due largely to the fact that, in the year 1536, Henry VIII suppressed the monasteries which had flourished since the eleventh century, and distributed vast sums of money, which they had accumulated, amongst his courtiers. Thus, nearly every nobleman in England became suddenly wealthy, and enabled to build for himself a house befitting his rank. A part of the funds from the suppressed monasteries was devoted to the erection of schools and colleges, so that this class of buildings, also, is intimately associated with the Elizabethan style of architecture.

131. Caius College at Cambridge was erected in the year 1574, and though the buildings were erected in the late Perpendicular Gothic style, the gates to the grounds were adorned with an abundance of classic detail, Fig. 111. Christ's College at London was founded at this time, though most of the buildings are of much more modern construction. The courtyard, shown in Fig. 112, is a fair example of the Elizabethan style of design. The square openings, with splayed jambs and molded drip stones, point clearly to a Gothic origin, while the row of flattened arches and central gate are strongly suggestive of classic detail. The gable over the gate, typical of the Elizabethan period, undoubtedly had its origin in Holland, while the ornament in the center of the gable

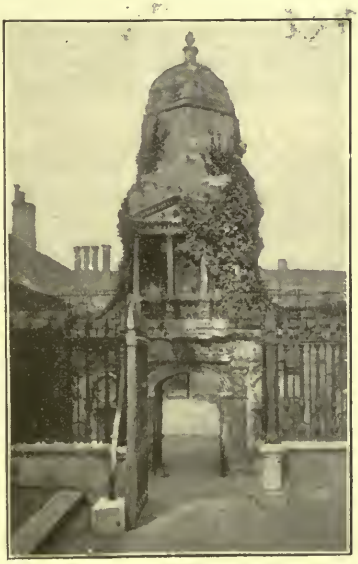


FIG. 111.

is strongly suggestive of the French rococo. The balustrade on top of the towers with its pierced panel work is another detail identified with the Elizabethan period, the origin of which is to be found in the later development of the Renaissance in other countries. Thus we see in the

FIG. 112.

incipient stage of English Renaissance a sparing use of classic detail, of which the architects knew but little. They borrowed forms from other countries, but the character of their buildings was not lost so long as complete servilism to classic forms was avoided.

132. These borrowed forms were never original at the time of their adoption by the English architects. They had already been altered by the late Renaissance in France, corrupted by the brick designs of Germany, and elaborated under Spanish influence by the sixteenth-century Hollander. When the English architect began to study the classic forms more carefully, he lost his originality, and, like his predecessors in France and Italy, copied the Roman orders and designs with the exactness and precision laid down by Palladio. When James I ascended the throne of England, the detail of the Elizabethan period was carried to its greatest

extreme. Everything was sacrificed to secure a startling and grotesque effect. The orders were used with a freedom that destroyed their character entirely. In many of the most important buildings, the columns were designed to be of greater diameter under the capital than at the base, to which they tapered without entasis. Pilasters were rarely designed with the smaller end under the capital, and were usually paneled and ornamented with an intricate plaited strap-work design in plaster. Grotesque figures of imaginary and human beings are carved as terminations of projecting brackets, hand rails, etc., and all idea of the grammar and propriety of ornament seemed to have been lost. This period lasted from 1603 to 1625, and the style, usually termed **Jacobean,** is the most inartistic in the history of English architecture.

133. The Elizabethan and Jacobean were nothing more than transitional styles from the Gothic to the Anglo-classic, and ceased to be practised as soon as the true Renaissance was introduced into England by Inigo Jones and Sir Christopher Wren.

Inigo Jones prepared himself by a long course of study in Italy with no less a person as his master than the great Palladio himself. In 1612 he revisited Italy to complete his studies, and on his return introduced into England a purer Renaissance style, founded upon the teachings of Palladio. The most important buildings designed by Jones were the Chilman Castle, Kent, in the transitional style (as though the architect felt somewhat timid in launching a pure classic design upon an inexperienced public); the palace at Whitehall, of which the Banquet House only was finished; and the Church of St. Paul, Covent Garden, an imposing little structure in the Tuscan order.

134. The greatest of Jones's successors was Sir Christopher Wren, the architect of St. Paul's Cathedral, London. Though he lacked the thorough technical education of his predecessor, Sir Christopher was a master of the art of construction, having studied his profession in France during

the rebuilding of the Louvre, and thereby trained himself in the French system of construction, which was then unsurpassed in any part of Europe.

His French education caused his designs to show the influence of that country more than the works of Jones did, whose compositions were purely Italian. Palladio's writings continued, however, to be the inspiring influences of English design, as Vignola's had been of the French; but Wren's compositions possessed much detail that showed its French origin and materially influenced the work.

135. St. Paul's Cathedral, the principal of his works, was 480 feet long, with a transept across the center of its plan 250 feet in length, and a rotunda at the crossing, 108 feet in diameter. The style was strictly Italian, but lacking

FIG. 113.

in variety and inspiration. The exterior is designed in two stories, Fig. 113, the upper one being a mere screen to hide the buttresses and clerestory, as shown in Fig. 114, which is a transverse section across the nave—a deception which illustrates the impracticability of the classic decoration on

the Gothic construction. If the buttresses had been permitted to show on the exterior, they would have been incongruous with the classic detail; and, on the other hand, had the roof been constructed according to the Roman methods, the building would have been ill suited to the purposes of a Christian church. The most important feature of the design is the dome over the rotunda. This detail is also an architectural deception practised to heighten the effect of the design on the exterior. If the dome were hemispherical and poised directly over the vault of the nave, as in the Byzantine churches, it would have added dignity to the interior without being at all visible on the exterior. Had it been designed to suit the exigencies of the exterior design, it would have appeared strangely lofty and out of place from within. Therefore, in order to reconcile these two conditions, Sir Christopher built a dome over the rotunda to secure the desired interior effect, as shown at *a*, Fig. 115; around the circumference, and independent of this dome, he constructed a conical brick roof *b*, on top of which is supported the stone lantern, and around the sides of which a wooden dome, *c* is built entirely for exterior effect. This exterior dome, rising from a high drum surrounded by a peristyle of Corinthian columns, gives to the design an expression of dignity and majesty which would otherwise be entirely lacking; while the campaniles, or bell towers, and the two-story porch on the west

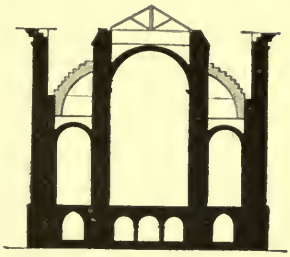


Fig. 114.

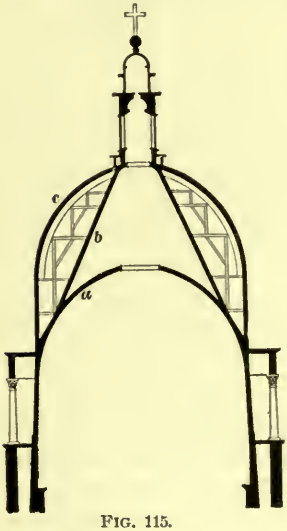


Fig. 115.

front, combine in an admirable composition, second only to the dome itself.

136. Besides the churches which he built, Wren was called upon to design more royal palaces than any other architect, before or since his day, but he did not in this field meet with the success that crowned the majority of his ecclesiastical designs.

The palace at Winchester was little more than a big brick barrack, to which purpose it has since most appropriately been applied. He was more successful with Hampton Court, though the design shows a want of proper study. The architectural orders are plastered on simply as exterior ornaments, and the entire facade is tame and meaningless. Chelsea College is probably the poorest design bearing Wren's name ever erected, but he partly redeemed his fame in the one at Greenwich, though this is not up to his standard.

When Sir Christopher Wren died, in 1723, he was succeeded both in practice and position by Nicholas Hawksmoor and Sir John Vanbrugh. The former was a pupil of Wren's, and was employed to carry out a good deal of his work. He built St. George's, at Bloomsbury; St. Mary Woolnoth; and St. George's-in-the-East, three edifices which plainly show the unsettled state of men's minds at this period. The first was a direct reproduction of heathen forms, being designed in part to realize Pliny's description of the mausoleum at Halicarnassus. The second was a design in which a strong effect was obtained by bold rustication and massive forms. The third, St. George's-in-the-East, is designed to get its effect entirely from its bold and massive character and detail, every trace of classic detail being omitted; the result, however, is a failure.

137. The works of Sir John Vanbrugh are all expressive of his one aim and desire; viz., to express in design a feeling of grandeur and eternity. Had his efforts been devoted to mausoleums and monumental structures, he might have

made much more of a success. But as his productions were almost entirely palaces and villas, his energy was pushed in the wrong direction. Blenheim Palace, Castle Howard, Seaton-Delaval, and Grimsthorpe all bear the stamp of his ambition.

Blenheim was to Sir John what St. Paul's was to Wren —the opportunity of his lifetime, by which he would be judged and with which his name would be handed down to posterity. To build a monumental palace in a noble park

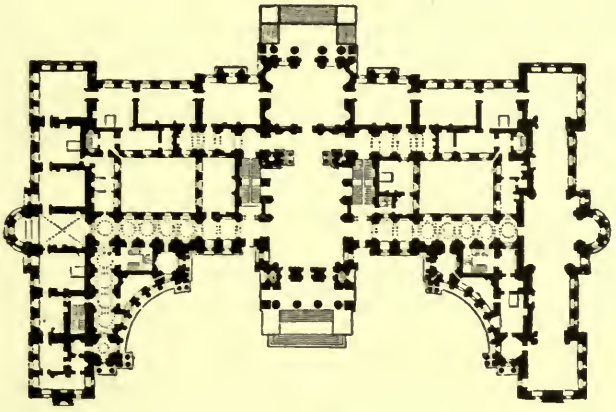


FIG. 116.

on such a scale, and to be backed by the nation's purse, was in reality a greater opportunity than Wren had before him when he built a metropolitan cathedral, hampered by liturgical difficulties and jealous criticisms.

Nothing can well be grander than Sir John's plan and general conception of Blenheim Castle, as shown in Fig. 116. The garden front, 323 feet in length, was flanked on one side by the private apartments, and on the other by a magnificent library 182 feet from front to rear. In designing the facade, he carefully avoided all the faults of Versailles, which was the typical palace of the day, as well as the tameness which was the feature of Winchester and Hampton Court.

Castle Howard, of which Fig. 117 is the elevation, was erected by him about the same time. It is similar in plan to

Blenheim, but much smaller, though his skilful treatment of the facade has made it appear much larger than it really is.

FIG. 117.

FIG. 118.

138. Somerset House, shown in Fig. 118, erected by Sir William Chambers towards the end of the eighteenth century,

was a very successful design, though far beyond the ability of the architect. The bold rusticated basement supports a range of three-quarter Corinthian columns, and a well proportioned balustrade surmounts the whole in a pleasing and artistic manner.

CLASSIC REVIVAL.

139. The essential difference between the architecture of the Renaissance and that of the Revival period may be thus defined. The former was the adoption of classic details to modern forms, while the latter required the complete subjugation of modern forms and necessities to accommodate the plan and arrangements of a pagan temple. Although classic details only were used in St. Peter's and St. Paul's, they could never be taken for anything but Christian churches. Whitehall and Versailles were the residences of the kings of the age in which they were built, and pretend to be nothing more. No one could think of St. Peter's as a Roman temple, and Versailles is as unlike the palace of the Cæsars as a building possibly could be, and so we find it throughout the three centuries during which Renaissance was practised. But, the Walhalla, at Ratisbon, pretends to be an exact reproduction of the Parthenon, and the Madeline, at Paris, is intended to be the counterpart of a Roman-Corinthian temple. St. George's Hall, Liverpool, is supposed to contain no feature later than the age of Augustus. Thus the early years of the present century were the beginning of a period of architectural slavery never before equaled. Architects no longer required originality, and he who possessed it was supposed to suppress it entirely, and reproduce some pagan building, line for line, fitting his purpose to the classic form, the best way he could, regardless of convenience, character, or tradition.

140. In Italy, there was, strictly speaking, no Classic Revival, as the Renaissance so thoroughly suited the tastes and requirements of the people that there was no demand for a change. In France, the frivolous designs and details

of the period of Louis XIV had become tiresome, and the prosperity of the country had so increased that the public impression seemed to be that the Empire of France was to be the successor of the old Roman Empire. Severity and dignity of design, rather than delicacy and frivolity, was therefore demanded, and the duplication, line for line, of Roman temples was the method of its accomplishment.

In Germany, however, the Renaissance style had been such a failure, that the country was not inclined to adapt any more Roman forms, and an adoption of purely Greek designs was substituted; while in England, the influence of Palladio, during the Renaissance, was still sufficient to modify the style when Great Britain adopted the Greek Revival.

The effect of this revival in all countries was to increase the dignity and monumental effect of the streets at the expense of the convenience and practicability of the plans. Public squares and parks, surrounded by colonnaded buildings and deep porticos, were very fine to look at, but the porches and colonnades darkened the buildings and rendered them unfit for the purpose of their erection.

141. In France, the Classic Revival made its appearance during the reign of Louis XV, and the tendency towards it can be seen even before that. The Hôtel des Invalides, Fig. 107, erected during the reign of Louis XIV, shows nothing but the most servile imitation of Roman forms, but at the same time admits the necessity of windows, which are grouped to harmonize with the design. In the Pantheon, at Paris, however, we see a noble building, architecturally asserting itself to be a Roman temple, when, as a matter of truth, it is a Christian church dedicated to St. Genevieve, Fig. 119. In plan it is a Greek cross, 362 feet long and 267 feet wide, over the intersection of the arms of which rises a dome, 265 feet high and 69 feet in diameter. The whole exterior is a cold, severe, but extremely refined, composition. The elegant portico of colossal Corinthian columns, and the fine peristyle around the drum of the dome, combine to

characterize the design as one of great dignity and effect. Its sides are plain wall surfaces, unbroken by window openings or carved ornaments, except the festoons along the

FIG. 119.

frieze under the cornice. Light is admitted through the roof, the greatest care and ingenuity having been exercised to hide the fact that interior illumination of the edifice was necessary.

142. The Madeline, Fig. 120, is even more extreme in the effort to depict a purely pagan design than is the Pantheon. Here we have what appears to be a Roman-Corinthian peristylar temple, every line of which is carefully proportioned according to classic antecedents, though its purpose is to provide a place for Christian worship. Classic as this structure may appear in design, it is certainly not so in construction, each column being built up of small pieces of stone, the joints of which materially interfere with the

effect of the fluting. The lintels, spanning the intercolumniations of the peristyle, are not single stone beams as in the temples of Rome and Greece, but are constructed of voussoirs like a flat arch. In ancient columnar architecture the spacing of the columns was governed by the length of lintel which could be conveniently quarried; hence, the intercolumniations were comparatively small. In the Madeline, the intercolumniations are still maintained accord-

Fig. 120.

ing to the ancient standard, though, as shown by the voussoired lintel, there is no structural necessity for it. But the Parisians desired their city to be a second Rome, and in order to carry out the appearance, they confined their architectural designs to the duplication of Roman edifices of historical renown.

This effort was not confined to architecture entirely, but the manners, customs, and even the dress of the people were as close an imitation of the days of ancient

Rome, as the climate and geographical conditions would permit.

Streets and public squares were embellished with columns of victory and triumphal arches, and statues of heroes adorned the parks. The Arch du Carrousel, Fig. 121, shows

FIG. 121.

how closely every detail of Roman custom was imitated, to the exclusion of every original idea, and to the detriment of the architectural advancement of the country.

143. In Germany, the Classic Revival wasted little time on Roman forms. This was due partly to the fact that the Renaissance has been so misunderstood, and partly to the inappropriate associations of Roman pomp and splendor with Germany's condition of finances. The long war between the Catholics and Protestants, in the seventeenth century, had nearly ruined Germany, while it had caused France to become the leading nation of Europe; and the next hundred years added but little to Germany's interests, while France continued to grow in power.

The German's taste then inclined to quiet and retiring ideas, and the recently discovered art treasures of Greece appealed strongly to his instincts. The literary works of the German poets, Lessing, Goethe, and others, diverted the public mind to the study of Greek art, and the discoveries of Stuart and Revett, and their publication of the "Antiquities of Athens," gave the contemporary architects models by which to be governed.

144. Leo von Klenze then erected, at Ratisbon, a monumental structure known as the Walhalla, which was exteriorly an exact model of the Parthenon, two-thirds the dimensions of the original at Athens. This architect saved himself an immense amount of responsibility by copying so

FIG. 122.

celebrated a building, and while praise may be due him for the accuracy of the reproduction, he is certainly deserving of the most severe criticism for the erection of so classic an edifice on a lone hill, where its sole surroundings are the high roofs and slender spires of the German villages.

145. The Ruhmeshalle, at Munich, Fig. 122, is E-shaped in plan, with a colossal statue of Bavaria occupying the central portion. It was erected to contain the statues, and was dedicated to the memory, of Bavaria's great men, and, though not copied after any Greek building, it is purely Greek in design, and correct in form and proportion down to the smallest detail. It forms a fitting background, and adds dignity to the colossal figure in front, without appearing unsuited to its surroundings, as did the Walhalla as above explained.

146. The Glyptothek, or sculpture gallery, at Munich, Fig. 123, was designed by the same architect as the Walhalla,

FIG. 123.

but though not a servile copy like the former structure, its most original feature, the Ionic portico, is its strongest defect, being out of proportion and distinctly unrelated to the detail of the surrounding parts.

147. In the city gate of Munich, Fig. 124, this architect was much more successful. The somber dignity of the Grecian-Doric order appears well suited to the purpose of this structure, and seems to have been well understood in principle by the architect. The design, though thoroughly Greek in spirit, is at the same time sufficiently modern to prevent the feeling that the intent and purpose of the monument has been in any degree sacrificed in order to suit the conditions imposed by the style.

148. The Greek Revival in Germany, presents the aspect of a sincere striving for beauty, on the part of a few talented architects, who labored under the false impression that the forms and details of an ancient and extinct civilization were suitable to the conditions of society as it existed at the close of the eighteenth and the beginning of the nineteenth century. The period is marked by examples of excellent planning, admirable construction, and most carefully

FIG. 124.

studied detail; but it failed from an artistic standpoint through the lack of harmony in social, religious, and political conditions of two peoples living twenty-two centuries apart.

149. Of the Classic Revival in England there is little in praise to be said. The modified Palladian style of Wren and his successors continued until superseded by the Greek Revival, which never succeeded in combining any two features of beauty and utility. A plain facade, with unmolded

rectangular windows, was embellished with a four or six columned Ionic portico and called Greek. Or a street front was erected without any windows, and covered with a sculptured pediment, to establish its style of architecture, while in the rear a multiplicity of windows gave the necessary light. Windows have always been the stumbling block of the revived Greek style, and the application of the revival to a modern structure requires the omission of the windows.

150. The Fitzwilliam Museum, at Cambridge, Fig. 125, is a well proportioned structure, whose purpose requires no

FIG. 125.

windows, and therefore fits itself to the style. The arrangement of the portico, the treatment of the pilasters, and the molding of the cornice, is decidedly more suggestive of Roman than of Greek models, showing how inefficient the pure Greek design is to a purely modern purpose.

151. St. George's Hall, at Liverpool, Fig. 126, is a building whose imposing peristyle and projecting porches are decidedly Greek in spirit, though the plan and details are decidedly Roman. The utility of the building, however, is sacrificed to a certain extent, as the colonnade cuts off the light and is an utterly useless appendage, except to stamp the design as belonging to the efforts of the Greek Revival. Thus, as in Germany, the application of the architecture of

the age of Pericles to the structures of the nineteenth century, was found to be impracticable, and after repeated efforts,

FIG. 126.

and almost as many failures, the style was abandoned and has ceased to be practised, except in rare instances, down to the present day.

RECENT ARCHITECTURE IN EUROPE.

152. We have now studied the progress of architecture and the development of architectural styles, from days of ancient Egypt to the middle of the present century. We have seen characteristic details in Greece grow out of constructive principles. We have seen the details adopted in Rome, while the structural device which called them into existence is ignored. We have seen the engineering science of the Romans, developed and improved by both the Byzantine and the Gothic systems of construction. But with these styles, *architectural* construction ceases to exist. With the Renaissance, architectural style and architectural construction were separate and distinct considerations. With the Classic Revival, style, construction, and arrangement of plan were each an independent problem, and the dawn of the nineteenth century found architecture in a thoroughly misunderstood condition.

This has been preeminently a century of progress, particularly in scientific, mechanical, and commercial lines, and the demand for utility in every structural detail, has

prevented architecture from taking its proper place in the march of progress. Nevertheless the artistic spirit has not been entirely crushed out by commercialism, and the numerous international exhibitions, the increase in the number of museums, schools of art, etc., have wakened a latent desire for something more than merely utilitarian construction.

153. It is in France, Germany, and England that we must look for nineteenth century development. Italy never emerged from the style of the Renaissance, Spain lost her power in the beginning of the seventeenth century, and repeated invasions and internal revolutions prevented any architectural advancement; while Holland and Belgium were so concerned in the political changes of Spain, France, and England, that little time was devoted to the fine arts other than painting.

154. In France, the existence of the "School of Fine Arts," at Paris, while tending to systematize and unify the national architecture, at the same time prevented a free development of ideas. In consequence, French architecture has adhered to the principles of the Renaissance, though slight breaks have occurred in the progress of a modern Renaissance development. These breaks were in the form of an attempt to introduce the Greek Revival, which failed, and a strong Revived Gothic movement, represented by a very able and celebrated architect and writer, Viollet-le-Duc. The Gothic movement produced no very important buildings, but it was fruitful in the restoration of a great many medieval churches and castles, which would otherwise have gone to ruin.

155. The reign of Napoleon III (1852 to 1870) was a period of exceptional activity, especially in Paris. The Louvre was finally completed by two architects, Visconti and Lefuel; the Tuileries was partly remodeled and completed by the same architects; the New Opera House was built by Garnier; and numerous public fountains, elaborate in design

and construction, were erected in streets, which were remodeled and extended at this time, making Paris one of the most monumental cities in the world.

156. Fig. 127 shows the south facade of the north wing of the Louvre, facing the Place du Carrousel. The treatment of the arcade, between the end and central pavilions, is vigorous and effective, and the two facing wings consti-

FIG. 127.

tute one of the most notable examples of modern French architecture. Fig. 128 shows the Pavilion Richelieu in the center of the above facade, from the details of which the character of the design may be more closely observed. The ornamental details are extremely refined and beautifully proportioned, and show plainly the influence of the National School of Fine Arts. Nothing in the design of this facade exists there without a reason—either traditional or structural—and all is harmonized according to a well governed system practised in the French school of art.

There are certain defects, to be sure, but the critic must hunt for them, as they are not glaring, and they are so out-

FIG. 128.

weighed by the good points in the design that there can be no hesitancy in commending the design as successful from every point of view.

157. The Academy of Music, or Paris Opera House, by Garnier, Fig. 129, built between 1863 and 1875, stands next

to the Louvre in importance as a national monument. It is by far the most elaborate and richly decorated building for amusements in the world, but in purity of detail and harmony and refinement of its design is far inferior to the Louvre. In this structure the public taste for gorgeousness is catered to, rather than the demand of the refined intellect

FIG. 129.

for harmony of proportion. This facade loudly proclaims the sentiment, "The nation is rich and can afford to spend its money on elaborate carvings, bas-reliefs, and painted frescoes." In contrast to this, consider the ancient Greek structures, whose every detail proclaimed, not wealth and egotism, but intellectual development and refined appreciation.

158. The systematic study required by the National School of Fine Arts, the restrictions of the government as to those who shall practise architecture, and the thorough education of the artisans, whose fathers have followed the same trade for generations back, have all combined to place

French architecture and the French style in design ahead of the rest of the world at the present day. While England has been wavering between two antagonistic styles, and Germany has vainly struggled with her classic forms, France has steadily advanced in the development of a modern school of Renaissance.

GOTHIC REVIVAL.

159. About the middle of the present century, a number of enthusiastic students of British medieval monuments endeavored to revive the Gothic as a national style of architecture. These enthusiasts were bitterly opposed by the practising architects of the Classic Revival, and the warfare became so active that it was a rule in the principal art societies that all discussion of the relative merits of the two styles should be suppressed. The medievalists finally prevailed, and the Gothic style is practised in England at the present day. This Victorian Gothic, however, is not the same as that of the twelfth century.

When the style was first revived, the general tendency of the practice was to make every detail archeologically correct; but it was soon learned that medieval Gothic was as ill suited to modern requirements as the classic Greek or Roman. Between the years 1850 and 1870 the striving for historical correctness of detail gave place to a rational effort to adapt Gothic principles to modern requirements, instead of merely copying extinct styles, and the result is a number of extremely interesting buildings.

160. Chief among these are the Parliament Houses, at Westminster, Fig. 130, designed by Sir Charles Barry, in the Perpendicular style. This immense structure is the most successful edifice in the Victorian Gothic style. Its masses are simple, and its detail is well studied and refined, while the entire composition is dignified and imposing. It is defective, however, in the proportioning of its details to the general mass. The former is made to appear insignificant by the vastness of its surroundings, and the two

principal towers—one at the angle and the other in the center—are out of proportion to the building and to each other. The central tower would appear much more imposing if not

FIG. 130.

dwarfed by the great Victoria Tower at the angle, while the latter would harmonize with its flanking facade if it were smaller and better proportioned to their details.

161. Other buildings designed in this style were inclined to the same excesses, so that at the present day architecture in Great Britain is suffering from the same uncertainty as at the beginning of the century—some architects still favoring the Gothic, while others are designing in the style of the Renaissance, and still others are endeavoring to draw an inspiration from the Revived Classic.

This is not an artistic age, and the striving for originality in design is preventing the advancement of architecture along healthy and rational lines.

AMERICAN ARCHITECTURE.

EARLY COLONIAL PERIOD.

162. The successful colonization of America was not accomplished until the beginning of the seventeenth century, and the hardships of the colonists were at first so great

that little attention was given to architectural development until the beginning of the eighteenth century. Buildings of stone were not undertaken by the early English colonists, though brick structures were erected in the southern and Dutch colonies.

About the beginning of the eighteenth century, the influence of Wren's designs in England began to assert itself to a small extent in the southern English colonies, though the structures were nearly all erected of wood or of brick and wood. From 1725 to the Revolution the population increased along the coast, and with the gradual acquirement of wealth there was an advancement in the character of the architecture, as seen in the dwellings and churches of the American aristocracy. During this period, the development of what is now known as the *Colonial style* took place. It was based upon ideas drawn from the Classic Revival in England, particularly that phase of the revival which appeared during the reign of Queen Anne. The details were extensively modified, however, by the use of wood instead of stone, and by the employment of designers who were not educated and trained in the Old-World architectural traditions. The style, especially in interior design, exhibited the taste and culture of the colonial aristocracy in its delicate and refined treatment of the woodwork, but there were no buildings erected in this style which were of a really monumental character. Stone edifices were very scarce, and the administrative buildings of the principal cities were small unpretentious structures, built within the insufficient grants of the crown.

163. The dwellings exhibit clearly the different tastes of the different colonies, though they all possess features of common origin in the mother country. In Maryland and Virginia, which were colonized by a wealthy class of English subjects, we find fine brick manor houses, extensive grounds, which are surrounded by high brick walls, and entered through broad gates of artistic design. The interiors of these southern colonial houses are usually very elaborate; large high-ceilinged rooms, whose side walls are decorated with

stenciled or frescoed patterns of the urn and festoon of the Adams brothers, in England. Rich mahogany sideboards of Sheraton design and bandy-legged furniture of Chippendale, together with broad open fireplace, suggestive of the reign of Elizabeth, form characteristics inseparable from the spirit of the design of the American colonial manor house of Maryland or Virginia.

164. In New England the majority of the residences were of wood. The plans were more compact, and the exteriors were more picturesque, but they were lacking in the dignity and stateliness of the southern manor. The interior details, wainscots, cornices, stairs, mantels, etc., were essentially the same as in the South, and each showed a skilful adaptation of the classic forms and details to the

FIG. 131.

slender proportions of a wood construction. Externally the orders appear as supporting details for veranda and porch roofs, and in the form of colossal pilasters flanking and subdividing the facades, as in Fig. 131, which is a view of the old Cragie House, at Cambridge, Mass., built in 1757.

The interest in American colonial architecture lies chiefly in the taste and ingenuity displayed in the translation of classic details from stone into wood. The American colonists were of English descent, and, persecuted though they may have been, they loved their mother country, and far from desiring to start any sort of an independent style of their own, they copied their designs from the contemporary English style, and erected in wood what they had not the means nor the skill to carve in stone, and took pride in the accuracy with which they adhered to the details of the parent style.

EARLY REPUBLICAN PERIOD.

165. After the Revolutionary War the new conditions of independence and self-government caused the American people to take a new interest in building projects, and to undertake the erection of structures which should be monumental as well as purely useful. Capitols and other buildings for the national and state governments, and municipal buildings in the cities, were erected at this time, and though the style was after the late Renaissance of Wren and his followers, there was a considerable admixture of French details, due no doubt to the active sympathy of the French people during the war.

The United States Capitol, at Washington, Fig. 132, was commenced in 1793, and consisted of the central portion of the present building, without the dome. The rusticated basement and high-columned portico, together with pedimented windows in the first story, and the square masonry openings above, are strongly suggestive of the facade of Somerset House, Fig. 118, and it is not improbable that Thornton, Hallet, and Latrobe, the successive architects, drew more or less inspiration from that edifice. The building was not finally completed until the year 1830, when, under the supervision of Charles Bulfinch, the two flanking wings were added, which make this monumental structure the largest and finest legislative palace in the world.

The dome is the principal feature, and rises from the

ground line to the top of the statue of Liberty which surmounts it, a height of 287 feet, while its diameter inside is 94 feet. It is smaller than the dome of St. Paul's, London,

FIG. 132.

but in point of design is superior to the creation of Sir Christopher Wren. It is also an excellent example of Yankee independence of traditional ideas.

166. The dome over the Pantheon, at Rome, is a concrete vault supported by massive walls. The dome over Hagia Sophia, at Constantinople, is a masonry construction supported upon four immense piers. The dome over St. Peter's is constructed in two shells, the inner one for interior effect and the outer one for exterior effect. Over the Hôtel des Invalides is a stone inner dome and a lead-covered outer dome of wood, while St. Paul's Church, at London, has an inner dome of stone, an' outer dome of wood, and between them a tall cone of brick to carry the stone lantern above the wooden roof. Thus there has been an advancement in the combination of design from an artistic standpoint, and design from a structural consideration, but the advancement has been at the expense of architectural honesty and

truthfulness. The exterior dome in these latter-day constructions is not what it claims to be by appearance—viz., the roof over a portion of the interior of the building—but is an exterior roof over an interior ceiling, with no connection or relation to the structural requirements of the interior at all. Down to the building of the United States Capitol, it was traditionally assumed that the architectural dignity of the structure required at least one of these domes to be of masonry construction, in order to be solid, substantial, and fireproof. But the design of the dome at Washington set aside all traditions, and called for a construction of one single material; namely, iron. No wood or stone is used anywhere. The absence of the former certainly insures it against fire, but the details are so suggestive of stone construction, that the design is even more untruthful than St. Paul's. A vast shell of wrought-iron trusses, cast-iron columns, and sheet-iron covering is so treated as to appear an architectural composition of stone; and though the details are well proportioned and refined, it detracts from the harmony to know that those details are products, not of the stone-carver's art, but of the patternmaker's and ironworker's skill.

167. The White House, Fig. 133, is the name given to the executive mansion, or residence of the President. This

FIG. 133.

structure, commenced in 1792, is a typical example of the Classic Revival in England. It was designed by James Hoban, an Irishman, and patterned somewhat after the

house of the Duke of Leicester, at Dublin. This, and the fact that it exceeded in size any private dwelling in America, gave cause for much opposition, and made Congress slow in providing the necessary appropriations. The building is constructed of sandstone, and several heavy coats of white paint, applied to protect the stone from climatic influences, caused the building to become known by its present name.

168. The University of Virginia, at Charlottesville, another classic edifice, was designed by Thomas Jefferson, the third President of the United States. The fact that Jefferson was an architect had much to do with the activity in building design at this period.

Another educational institution, Girard College, at Philadelphia, Fig. 134, shows to what extremes the Classic Revival was carried even in America. This building is designed

FIG. 134.

to appear as a Roman temple, 218 feet long and 159 feet wide, and with its columns 6 feet in diameter and 55 feet high, its marble exterior might have rivaled the Walhalla, were it not for the fact that instead of a cella, the colonnade

encloses a very ordinary two-storied college building. Its details are well executed, however, and its designer, in applying the elements of a Roman temple to the purposes of a modern college, was committing no greater error than his

FIG. 135.

contemporaries on the other side of the sea, who had been endeavoring to accomplish similar impossibilities for three decades.

Other examples of the Classic Revival in America are the Treasury and Patent Office buildings in Washington, the Mint at Philadelphia, and the Subtreasury and Custom House in New York.

169. The decline of the Classic Revival, and the rise of the Victorian Gothic, in England, immediately found its echo in America, and Trinity Church in New York, Fig. 135, designed by Upjohn, in 1843, as well as Grace Church, by Renwick, are worthy examples of modern Gothic work.

170. Between 1870 and 1880, the disastrous fires at Chicago and Boston gave unexampled opportunities for architectural improvement in those cities, and greatly stimulated public interest in the art.

The establishment of architectural schools in Boston and New York, and the opening of public museums of art in the principal cities, caused the American public to wake up and be more critical of the things around them, and to demand a higher grade of architectural design.

At this time the personal influence of two men comes into great prominence: Richard M. Hunt (born 1827, died 1895), and Henry Hobson Richardson (born 1828, died 1886). These men, educated at the French National School of Architecture, showed the American public that architecture was a fine art, and not a mechanical trade, and made them understand that the architecture of a country was the key to the education, refinement, and social condition of its people.

171. In Hunt's office, many of the most prominent American architects of the present day received their early training, while the works of Richardson exhibited such an independence of the prevailing styles in foreign countries, and at the same time so well suited the purposes for which they were erected, that, had his successors and followers understood the art better, a new style of architecture would likely have evolved.

Trinity Church, at Boston, Fig. 136, is considered one of Richardson's masterpieces. The design is what might be termed Romanesque, not in the sense of an adaptation of tenth-century Romanesque to American ideas, but an application of the Roman-arched construction to the nineteenth-century conditions. Broad, blank wall spaces of rock-faced masonry

are left where windows were not required, thereby presenting a rough, gladiator-like expression of crudity, characteristic of the period when the architecture of every country of Europe was feeling its way from the rejected classic arch towards the perfected Gothic vault. This architecture of Richardson's was true in its construction. Everything was real; no false domes and senseless pilasters crowned the roof

FIG. 136.

or graced the walls. Everything existed because it was needed, and details not wanted were omitted, without any attempt to fill blank wall spaces with relieving ornaments.

172. The opening of the French National School of Fine Arts to American students had a very marked effect upon the art education of the American people. Libraries were stocked with architectural works, which would have been too expensive to have been purchased by the individual student, and all the important journals and publications of

the day were soon at the service of any one who cared to study them.

The great Public Library, at Boston, Fig. 137, is one of the largest and most important of these educational institutions. It was designed by McKim, Mead, & White, a firm of architects prominent through their adaptation of the design of some of the best buildings of Europe to American uses. The Boston Library was an American rendering of the Library of St. Genevieve, at Paris. The New York State

Fig. 137.

building at the World's Fair, Chicago, by the same architects, was patterned after the Villa Medici (see Fig. 96). The tower of the Madison Square Garden, Fig. 138, is a very clever adaptation of the Giralda, at Seville (see Fig. 108). This adaptation of individual buildings is certainly not the highest form of art, but it presented for the study of the people a variety of good designs, which made them more appreciative of the architectural merits of their cities, than would a lot of more original, more artistic, but less successful compositions than the Boston Library or the Madison Square Tower.

173. Richardson designed and built about fifty prominent buildings in all parts of the United States, among

which are the Court House at Allegheny, Pa.; parts of the Capitol at Albany, N. Y.; Armory at Detroit, Mich.; State Asylum at Buffalo, N. Y.; and also the exhibition building at Cordova, in Argentine Republic, South America.

Richard M. Hunt was more identified with residential architecture than with public buildings, and though his designs for mansions and villas were harmonious and above

FIG. 138.

reproach, and are represented by the most elaborate and expensive dwellings in America, his great service to the profession, and indirectly to the architectural elevation of the country, was in his establishment, in his office, of a regular system of instruction and training for architectural students, and it is to this system, and to those that studied

under it, that we are indebted for much of the better architecture of the present day. Among these students were Wm. R. Ware, afterwards Professor of Architecture of Columbia University; Henry Van Brunt, a prominent architectural writer; Geo. B. Post, of New York; Furness, of Philadelphia; and Gambrill, who, until his death, was the partner of Richardson.

Each of these men carried into his own practice the systematic style of Hunt's methods of working, and helped to establish in the general architecture of their several localities an appreciation of the value of good architectural composition.

174. Hunt's early architectural training was in the *atelier*, or studio, of Hector Lefuel, in Paris, when he was 18 years of age, and he pursued his studies at the French National School of Fine Arts, for nine successive years.

FIG. 139.

During these years, Lefuel was appointed by Napoleon III as architect to complete the northern gallery of the Louvre, the most important feature of which was to be the central pavilion. As a pupil of Lefuel's, Richard M. Hunt designed this pavilion, and it was erected, with but slight alteration, under Hunt's personal supervision, when he was afterwards appointed inspector of the works.

Thus it was that one of the most important structures in modern French architecture was designed and erected by an American architect. It is not surprising, therefore, to find Hunt's designs all more or less influenced by the French style and school of design. The residence, or city château, of W. K. Vanderbilt, Fig. 139, is one of Hunt's masterpieces. Situated at the intersection of two of New York's busiest residence streets, it does not fit its position as well as it might with wilder surroundings. Its design is original, though suggestive of the Château of Chenonceau (Fig. 99), or Azay-le-Rideau (Fig. 98), and even in its urban location has a precedent in the house of Jacques Cœur, at Bourges, France, (Fig. 86).

COMMERCIAL ARCHITECTURE.

175. To the nineteenth century, and especially to the two last decades of the nineteenth century, history is indebted for a new architectural structure—the office building. This is essentially an American creation, evolved from the necessities of a centralized commercial trade. Business and professional men have always required offices, but it is only within the past quarter century that circumstances have demanded that these offices shall be localized according to the business or profession predominating in the neighborhood. Lawyers require offices near the court houses; brokers and bankers demand offices near the exchanges; commission merchants, manufacturers' agents, and insurance solicitors each require certain surrounding conditions of trade, to make the locations of their offices desirable; and to supply the ever increasing demand, the multistoried office building has been "invented."

176. When, on the corner of Wall street and Broadway, New York, there was built a nine-story office building for the First National Bank (see *a*, Fig. 140), it was considered a remarkably lofty structure, being about half the height of Trinity Church spire, the then highest edifice in the city. Within the past ten years, there have been erected all over

FIG. 140.

the country "sky-scrapers," beside which the old First National Bank Building retires to insignificance. The American Surety Building (see *b*, Fig. 140) is one of these, and though by no means the highest office building in the city, its twenty-one stories loom up well above the nine stories of the bank building, and overlook the uppermost point of Trinity spire itself. The American Surety Building is an excellent example of harmonious design under trying circumstances. A building whose height is five times its width, and whose facade can be viewed squarely from a point only 80 feet distant, does not present an easy problem in composition and design; but the well placed string-courses and cornices, and the systematic emphasis and grouping of certain openings, divide this tall mass into pleasing proportions, and give it dignity, breadth, and harmony.

177. American architecture reached its climax in the World's Fair, at Chicago, in 1893. Here were exhibited, not

FIG. 141.

only the products of the arts and sciences of nearly every nation on the globe, but assembled in harmonious juxtaposition were buildings designed and erected by the best architects in the United States. America had never been looked

upon by her foreign sisters as of much importance from an architectural standpoint, but the president of the Royal Institute of British Architects, in a speech before that society, pronounced the Court of Honor at the Chicago exhibition (Fig. 141), "the grandest thing architecturally the world had seen since the age of Pericles."

CONCLUSION.

178. The review of a larger number of buildings erected in the nineteenth century would show no idea or development of greater importance than those already referred to, and as architects today are no nearer the invention of a new style than they were two hundred years ago, the examples given are sufficient to show the progress made in this direction. The questions are often asked, Why do we copy ancient forms and never invent new ones? Why must all the nineteenth-century architecture be a reproduction of the Renaissance, Romanesque, or Gothic styles, and never strictly original and peculiar to the present time?

These questions may thus be answered: It must first be borne in mind that there are but two original styles of architecture—the *Pagan* and the *Christian*, otherwise called the *Classic* and the *Gothic*. All other styles, at the best, are but diversified forms, affected by local combinations, mannerisms, and individual caprice. So that the natural tendency in the practice of architecture has always been little more than imitative of the past, a radical change having been accomplished only through the inspiration or enthusiasm of some grand religious, political, or social revolution. The conquest of Greece by the Romans gave birth to the Roman style of architecture, while the emancipation of the Christians by Constantine was the corner stone of a beautiful style soon to be perfected. The Romanesque shows us the gradual education of the people, and the Gothic expresses the grand thanksgiving of the enlightened soul and its glorification of God.

The enlightenment and education of the people towards the close of the fifteenth century enabled them to read for themselves what had heretofore been taught only by the priests; enabled them to judge for themselves what before had been interpreted only by the clergy. Different opinions thus arose, which led to a division of the church, and the demoralizing effect of this schism is shown in the character of the contemporaneous and subsequent architecture. The introduction of pagan forms and details, the imitation of Roman luxuries and extravagances, mark the character of the Renaissance period, while the Classic and Gothic Revivals show the tendency of one class towards the intemperate admiration of heathen art, while the other class, led by the church, endeavored to instil into the world at large a proper love and admiration for Christian forms.

Thus, we see that in modeling after preexisting forms, we are simply following the course which has been pursued ever since the infancy of art, and if the development of a new style in the future depends on a repetition of events similar to those which have caused architectural revolutions in the past, the prospects for its fulfilment are not very assuring.

ARCHITECTURAL DESIGN.

NATURE OF DESIGN.

INTRODUCTION.

1. Design in general as applied to architecture treats with the disposition of the parts so as to please the senses, in contrast to the mechanical arts, where *design* means proportioning and grouping of parts to serve some useful end. Architectural design is complicated with practical considerations of such magnitude and importance, that they are usually set forth as constituting the entire subject, to the exclusion of esthetics entirely.

The most important of these considerations is *utility*, as at the present day nearly all architectural work is for some useful purpose. In past ages, when architecture found expression chiefly in structures erected as dwellings for the gods, utility counted for less, and the considerations of beauty and reverence were paramount. But now we must build houses, town halls, and office buildings, and develop our design from such stern utilitarian demands as minimum cost, maximum floor area, light, access, etc. Sentiment, too, sometimes plays an important part, either religious or domestic, or that of pride, or even ostentation, and the architect is expected to combine a dozen points of utility and half as many sentiments in a single design.

The next consideration is *construction*, both actual and

apparent, for even the untrained eye will detect a post or beam which looks too small for the work it is doing, and in these days of cast-iron columns and rolled-steel beams, construction which may be actually sound and reliable is likely to appear too weak. This brings us to another practical consideration—that of *material.* Cost, location, and sentiment may combine to dictate whether our edifice shall be erected of stone or brick, bronze or iron, marble or plaster, and all these considerations are to be satisfied before we can make one step towards the *composition* of our design.

COMPOSITION AND DESIGN.

2. To define the exact meaning of the terms **composition** and **design,** and to clearly explain the relation each bears to the other, is a somewhat difficult task.

The term *design* is usually applied to express the origin of some particular art form, such as Egyptian design, Renaissance design, Gothic design, etc.; while *composition* is the preparatory operation of the act of designing, the mental grouping of the parts of a design, and the proportioning of those parts, one to another.

Composition has nothing to do with the origin, history, or symbolism of any form, but deals solely with the outline of the mass and the general effect, exclusive of detail, ornament, and finish.

A well designed building is one where the whole mass, considered as a solid block, is of pleasing proportions and outline; the arrangement of its openings and wall spaces, and its high lights and deep shadows, are well studied; while the ornamentation of its details is sufficient to attract the eye to the beauties of its proportions, but not so excessive as to distract the observation from the composition of the whole.

Good composition is in itself an art. Its laws have been determined by a close observation of the methods of working of the best architects of all ages—precisely as the rules of

grammar have been systematized by a careful study of the way in which all the best writers have written. Subsequent generations have been guided by these studies, following the ancient examples in all that they considered good, and avoiding such parts as their tastes have dictated.

3. Let us first consider the nature of the problem involved in architectural composition. What are we trying to accomplish when we *design* a building? What is the fundamental problem before us in every case? To what end do we work, and how do we start to reach it?

Our client demands a structure, the utility of which shall be in no way impaired, in order to secure an artistic effect. Our taste requires that the design of the building shall express the purpose of its existence, be pleasing to the eye, and be an ornament to the neighborhood in which it is erected. Now, shall we surrender entirely to the utilitarian conditions and let art have no place in the design? Shall we have a minimum regard for utility, and sacrifice convenience and stability in the endeavor to make our edifice appear a work of art? Or, shall we harmonize these conflicting considerations of beauty and utility, and reconcile the practical needs with our esthetic demands, so that neither need be sacrificed to the other? This is the ideal solution of the problem and the only one deserving consideration. We clothe the masonry or carpentry skeleton so that the form pleases the eye, while the proportions perfectly accommodate the necessities of construction and utility. This is what architecture seeks to do, and wherever it fails in this, it fails in the fulfilment of its purpose.

To obey the unalterable laws of statics, and carry out the artistic requirements of proportion; to make the necessities of the internal planning the very means to external dignity and beauty, securing the latter by means of the former and not in spite of it; to bring success out of the stern demands of the utilitarian client, by making those demands themselves minister to the beautiful—such is the task of the true architect. Every noble design accomplishes this to a certain

extent, and the composition approaches ideal perfection in proportion as these requirements are harmonized. Sometimes, the artistic temperament, if unrestrained by technical education, will give loose range to its conceptions, subordinating thereto convenience, propriety, and even stability. On the other hand, utility alone receives attention, and the structure becomes a mere work of engineering, possessing no more architectural effect than a railroad embankment.

4. A common brick factory, such as shown in Fig. 1, furnishes a fair example of the first so called solution of the architectural problem, while the magnificent colonnade of the Louvre (see Fig. 106, *History of Architecture*) serves as an illustration of the second. The brick factory makes no claim to being other than an enclosure to some manufacturing plant, and the colonnade of the Louvre is not required by any consideration of practical use; it is added to the palace solely for its own sake, namely, effect. It certainly is beautiful to look at, but good planning and rational construction are both sacrificed to secure it.

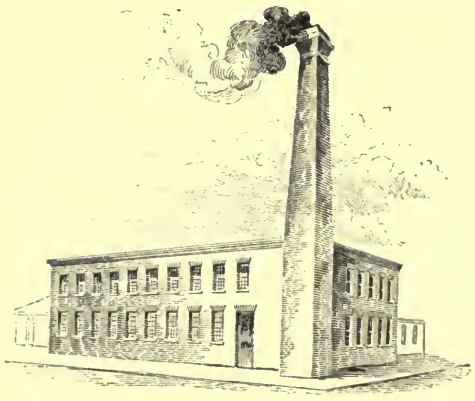


FIG. 1.

The third and ideal solution, as above stated, has been the aim and effort of all architects in all periods of art. Some have leaned a little more to the practical, and others towards the esthetic; but it is plain to be seen, in all great architectural works, that the effort has been to blend the two and to surrender to neither.

With this conception of architectural composition, we have a proper idea of the work of an architect. The study and preparation of a design, from this point of view, is

intellectual work of the highest order, far different from the mere drudgery of fitting various rooms together and surrounding them with an exterior that will produce the most showy and startling elevations. This lofty point from which we approach our task makes it far more difficult than from any other point of view; but our work acquires dignity and importance by it, and we discover that the smallest rural cottage and the palace of a king furnish problems differing only in degree and not in kind. In each are certain unalterable conditions of practical necessity. In each are certain artistic considerations of form, of proportion, and of ideal beauty which must be combined in a whole, every part of which shall satisfy both sets of conditions.

5. Reference to architectural history may serve to make this clear. Such history begins in the Valley of the Nile, and there all the Egyptian architecture is most powerfully impressive because of the predominance of religious symbolism and the ideas of sublimity and eternal duration. The laws of statics and practical convenience are not disregarded, but are made use of with tremendous excess of material and strength. The ruins of the temple at Karnak (see Fig. 3, *History of Architecture*) make one stand speechless with wonder and awe. Its columns and masses of masonry produce an overwhelming impression of grandeur and power. It is not good engineering—nor even rational building—but it is stupendous. And yet, though much smaller in every dimension than these gigantic Egyptian ruins, the Parthenon at Athens fascinates and commands the admiration of every one by a spell much more potent. All cultivated minds yield to its beauty the tribute of their unstinted admiration; because, even in its ruins, the Parthenon perfectly fits its surroundings, meets the requirements of its original purpose, and satisfies the sense of proportion and form.

6. The architecture of the Romans, in contrast to this, shows that they did not understand the intimate relations between fitness and beauty as well as the Greeks did. The

Roman design combines fitness and beauty, but each has received a separate and conservative consideration. Its beauty is entirely superficial, not contradictory to utility or stability; but, with the exception of the vaulting, it is not incorporated into the fabric of the structure itself. This is most clearly shown in the *orders* and their combination with the arch. No principle of construction is sacrificed to the beautiful combination of straight and curved lines, but one never feels that these are the outcome of the needs of the building, as with the Greek orders. In Byzantine art there is a return to the principles of the Greeks. The structures we meet with here are examples of excellent engineering, wrought out by artistic minds. The necessity of every vault and pier is evident at a glance, but these same vaults and piers might have been arranged by less artistic hands and have been the direct reverse of the well proportioned and stately structures they are. And yet this stateliness is wholly independent of the ornamentation with marble and mosaics, with which the piers are incrusted, but is the direct outcome of wise scientific construction.

The marbles and mosaics play the same part in Byzantine as the orders do in Roman architecture. Strip them off, and the Byzantine building still retains a certain beauty born of the dignity and grace of the proportions of its parts; but similarly strip the Roman buildings, and they look naked and desolate.

As a matter of fact, the real importance of Byzantine architecture lies entirely in its system of *composition*, apart from its system of decoration. Here the *construction* is the starting point and the basis of its architectural effect, and this system is the same that controlled all medieval buildings except those of Italy, where the old Roman system of design retarded its influence. The aim of the architect, during the middle ages, was not to construct an ugly shell, to be subsequently concealed or embellished, as are most of our modern buildings, nor on the other hand, was it to mold practical requirements so as to fit certain chosen forms, as the Romans had done; but his purpose was to construct rationally, and

to study the construction with a constant regard for its decorative effect. In medieval architecture the requirements of the *vaulting* were in nearly every case the cause of every feature of its design, and the alliance between beauty and utility in medieval work is almost as wonderful as in the Parthenon itself—though we can hardly compare buildings of such different periods or styles, on account of the difference in their origins, the Greek starting from conceptions of pure beauty, and the Gothic from conceptions of good construction.

Both styles, however, unite both conceptions in the final results, though these results were widely different, on account of the different conditions—social, intellectual, religious, and practical—to which each owed its birth. The architecture of the Renaissance period is still different from either of these.

7. Though they adopted the whole scheme of Roman art, the Renaissance architects clung for a while to the methods and expressions of the medieval builders. Moved by the general current of popular thought, they turned to classic art, as the scholar turned to classic literature, and adopted the Roman architecture, without a thought as to the circumstances of its origin.

Caring little for the formal grandeur and monumental dignity of this borrowed architecture, the Renaissance architects applied it to their own uses and gave it a freedom, plasticity, delicacy, and variety entirely unknown in Rome itself. During the reign of Francis I in France, we find a most curious display of Gothic ideas and Gothic composition set forth in classic language. Columns, pilasters, and entablatures are most fancifully and freely treated, as shown in Fig. 101, *History of Architecture.* The works of this period are full of grace, originality, and refinement, and are well planned and wisely built. The new forms fit their places perfectly, and require no forcing of the plan or construction to fit them to a set of forms ordained in advance.

At the same time, the orders, although useless as an

adjunct to the construction, were used so freely as not to interfere with the composition in the least; that is to say, they were used more as a suggestion of a scheme of design than as an absolute model which is not to be deviated from. The early Renaissance architects designed for their structures a column and a capital that was somewhat like the Roman Corinthian, but was not an exact reproduction of it. They used the model freely, but altered it to suit the requirements of its new position and modern surroundings. The foliage on the Roman Corinthian capital was the classic acanthus; while the foliage on the early French Renaissance capital was the grape, ivy, or other leaf up to that time used as a Gothic emblem.

In the early Renaissance work, the composition is as good and rational as the Gothic from which it sprung, and in many cases it is broader, more dignified, and more refined.

In the later Renaissance architecture, we find the stiffness and formality with which we are liable to identify this style of art. Constant study of the works of Vignola and Palladio had caused the architects to model their designs to suit the orders, instead of subordinating the classic detail to the primary requirements of the modern design. Their main idea seemed to be that the more columns and pilasters the building displayed, the grander and more dignified was the effect, entirely overlooking the fact that what was originally designed for amphitheaters, temples, and triumphal arches, was scarcely applicable to cottages, villas, and noble mansions. And while they sacrificed propriety and convenience to this supposed symmetry and false dignity, the real element of beauty in their works suffered still more from a decline in the skill and taste of their artists.

The designs of the earlier part of this period were refined and elegant, but the coarse lavishness, and the frequent vulgarity and monotony of the Rococo and Louis XV periods, which replaced this refinement, express the general degeneration of the times which followed. Yet degenerate though they were, there is much in these works worthy of study.

From Roman to Gothic the trend of architecture was

from mass to detail—from excess of material to economy of material, and from the ideal design to the practical use. Through the Renaissance to the Rococo there was a tendency towards a return to mass and massiveness, and towards ideal form; but from then till now the trend has been steadily in the direction of economy of material and a utilitarian conception of design.

8. It should now be apparent from the preceding considerations, that the all-important thing in architecture is neither *style* nor *originality*, but simply *beauty*—beauty associated with, and conducive to, the very best construction, and yet in itself paramount. It should also be evident that beauty is not exclusively possessed by any one style, and that no particular style is worthy of study beyond all others. Every building is to a certain extent good, in which utility and beauty, strength and grace, construction and composition are united in one whole, so as to please both the intellect and the artistic emotions.

THE ELEMENTS OF BEAUTY.

9. No man has ever been able to give a concise definition of *beauty*. Long essays have been written upon what constitutes the beautiful, but none of them has definitely and comprehensively defined the subject. The fact is that beauty is simply an emotion or sensation produced by a combination of forms, the sight of which creates pleasurable impressions in the mind. Beauty itself, then, cannot be defined clearly, any more than can the emotions of joy, sorrow, or pain; but the underlying characteristics of the forms which produce the sensation of beauty can be studied and compared. If an architectural composition can be beautiful or not beautiful, according to differing conditions, then we must learn what the underlying principles, which determine these conditions, are.

The elements of beauty may be considered as embracing:

(1) the expression of unity in variety; (2) the activity or presence of rational or spiritual personality; (3) perfection of form.

The *first* is the principle that was recognized by the ancient Greeks. Their temples were composed of a multitude and variety of parts, but the expression of *unity* was maintained throughout and no part could be removed from the composition without impairing the beauty of the whole.

The *second* principle is the one practised by the Gothic builders, who imbued their works with a feeling of the presence and personality of the living God.

The *third* principle is characteristic of the later Renaissance period and of the present day. Besides these principles, there are the elements of utility, delicacy, and grandeur, each influencing the general principles to a greater or lesser extent, according to circumstances. These may be best illustrated by more commonplace applications.

10. A woman, richly dressed and reclining on a cushioned lounge, within a brilliantly lighted drawing room, may, with her surroundings, present an impression that excites the mental emotions of the beautiful. The same individual, however, in the open street, during a pouring rain, would, by the impropriety of her dress and adornments, destroy the emotion of beauty entirely. On the other hand, were she wearing a mackintosh and walking under an umbrella, the fitness and utility of these details, though not expressive of beauty, would not discord in the mind as in the previous case. In the French Renaissance period, a mode of decoration frequently met consisted of the capital of a pilaster formed by two carved figures of Cupid, whose uplifted hands supported a delicate architrave of floral design or simply of festoons. These delicate designs impressed the mind as beautiful—not because they suggested any historical architectural form, for they did not; but because there was propriety and fitness in the wreaths and festoons being held in place by the baby figures. But the Jacobean period in England, when similar Cupids were caused to occupy the

top of a bracket or window mullion, and upon their shoulders and outstretched hands support the lintel and two or three upper stories of the building, the idea became ludicrous and lost all power of exciting an emotion of beauty.

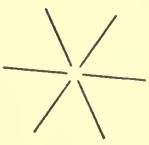
11. The elements of delicacy and grandeur exist only when the design is either inferior or beyond the scale of what is usually understood as beautiful. The carving of the above mentioned Cupids or the molding of the frieze they support may be delicate and refined to the greatest degree, and yet, though pleasing, fail to stimulate the emotion of beauty. Such a composition is usually called *pretty*, it being a trifle frivolous in its conception, or lacking somewhat in dignity. On the other hand, where sturdy columns support elaborate architraves and superimposed orders lead the eye along through countless arcades, or when massive buttresses receive the thrust from the lofty vault over the nave, and pinnacles and crockets unnumbered profile their outline against the sky, the emotions exceed all idea of beauty and the work becomes *grand*, *imposing*, or *magnificent*.

COMPOSITION.

UNITY.

12. As above stated, *composition* in architecture deals only with outline of mass, and grouping of parts; the grouping of the parts being such that it gives to the whole design an expression of unity. Fig. 2 shows six equal lines drawn at random without unity, while Fig. 3 illustrates how the same lines may be united by the method of their arrangement. This arrangement need not necessarily be symmetrical, so long as all the minute details are grouped in one whole mass. The great Gothic cathedrals are particularly unsymmetrical,

Fig. 2.



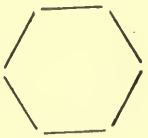


Fig. 3.

yet their details are so grouped as to produce an impression of perfect unity.

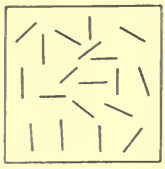


FIG. 4.

Another method of producing unity of impression is to surround the detail with objects of more importance, as illustrated in Fig. 4, where the random lines are unified by the enclosing rectangle. In Fig. 5 the lines are grouped to form a series of rectangles and then grouped in one large rectangle to unite them. This principle is observed in the facade of the Foscari Palace in Venice (see Fig. 82, *History of Architecture*), where the minutely carved windows and tracery are framed in a wall mass to give them unity and repose.

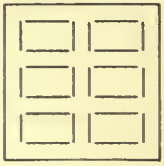


FIG. 5.

13. If objects are arranged at regular intervals, even though the grouping may be good, the impression of unity is not produced unless there is an effort made to define the point where the repetition ends. Thus, in Fig. 6, the lines are well grouped and evenly spaced, but the impression is one of *continuity*, but not of *unity*. The mind grasps the outline only partially and feels that the repetition is unlimited, unless there is some detail at each end to stop the continuity and produce a feeling of repose. The wing of Louis XII in the Chateau de Blois exhibits this treatment very plainly, and as shown in Fig. 101, *History of Architecture*, the flanking-stair towers at each end of the colonnade and repeated dormers stop the feeling of continuity and unify the composition.

FIG. 6.

The design should always be in repose; that is, there must never be an uncertainty as to where the eye should rest. If we study a noble building, we should judge its entire mass as a whole, and if the secondary details are so badly grouped that the eye wanders from one to the other without deciding which is the most important, there is something wrong in the composition and the building lacks repose.

14. Architectural composition consists primarily of two general processes, in each of which the consideration of unity is of the greatest importance. The first of these processes consists of assembling numerous adjacent details into one mass or group, as shown in the diagrams, Figs. 4 and 5. This process is called *grouping*, and is of paramount importance in giving an expression of *unity* to a number of separated parts. The second process, while apparently antagonistic to the first, is in reality part of, and subordinate to, it. This consists of the separation of the building as a whole, into horizontal masses of definite relation to each other. This process is called *subdivision*. In a general sense, then, the term grouping may be considered as referring to vertical elements only, such as gables, spires, chimneys, etc.; while subdivision is used in connection with the horizontal details, defined by the cornices, belt and sill courses, or the grouping of the stories of the building. After the grouping of the component parts of the entire structure comes the grouping of the details, the same rules applying to the minor parts as to the main structure itself.

GROUPING.

15. In assembling subordinate details to secure unity of mass, there are three groupings which completely satisfy the mind as to a sense of unity. One single mass always looks well alone, unless improperly subdivided or surrounded by discordant parts. Conspicuous and well defined *oneness* is characteristic of most of the great architectural monuments of ancient times. Oneness is not the same as unity, but means a mass consisting essentially of one part; while unity describes a mass wherein many parts unite to constitute a whole. It is not strictly correct to speak of a group of *one*, but is necessary here, in order to properly emphasize the importance of this singleness. The pyramid of Cheops, the Parthenon, and the Farnese Palace (Figs. 1, 20, and 94, *History of Architecture*) are examples of this oneness of feeling, as distinguished from the pylons of the temple of

Philæ or the Propylæa at Munich (Figs. 6 and 124, *History of Architecture*), which are each composed of two parts, or a modern country house that may be composed of eight or ten parts. The Hotel des Invalides is another example of unity presented by one general mass. The tendency of the outline of this building is pyramidal and emphasizes the singleness of its character.

16. A group of two things can be made to look well unless there is too great a difference in their form or size, or unless they are unsatisfactorily linked or united. The towers of Notre Dame Cathedral (Fig. 78, *History of Architecture*) are excellent examples of unity produced by a group of two, as is also the western facade of Westminster Abbey and the

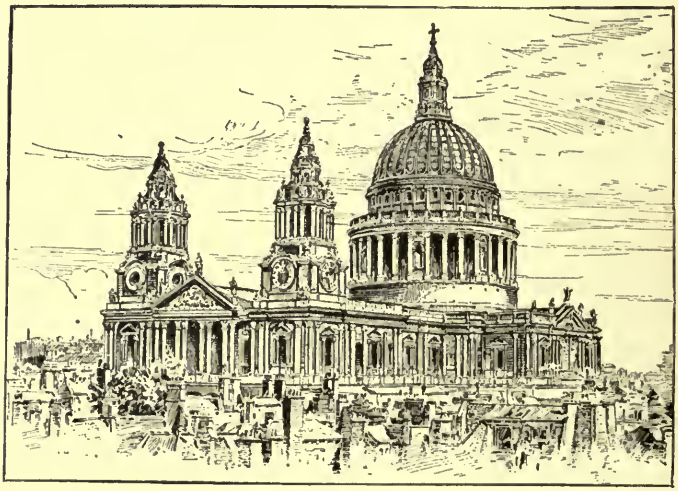


FIG. 7.

Propylæa at Munich (Figs. 77 and 124, *History of Architecture*). The Cathedral at Florence (Fig. 87, *History of Architecture*), however, does not present such a satisfactory appearance. The two most prominent elements of the design, the dome and the tower, are too unlike to be successfully united, and the impression is lacking in repose.

17. A group of three things usually looks well, but the group must not be of principal details of a uniform size. Three arches in an arcade, three windows of equal proportions, or any three details of minor importance can be grouped without difficulty; but three equal towers as the main mass of the building, or three domes in the roof, or any three elements of equal importance would be impossible. In a group of three important elements in any design, one of the three should be the largest, or if two must be of equal size, the third should be subdued in order to unite them in a group of two. When one of the three is the largest, the other two may be equal or of different sizes, but all must be of the same general form.

18. The members of a group of three need not be of

FIG. 8.

exactly the same form, though they should resemble each other sufficiently to give at first the mental impression that

they are alike. Take for instance the towers and dome of St. Paul's Cathedral at London, Fig. 7. Here are seen the western towers and the central dome, utterly unlike in form and purpose. The dome, however, so takes up the mind that the towers are not considered until the dome has made its full impression. The towers therefore become a subordinate feature in the roof treatment, while the dome dominates everything around it. In the western facade, Fig. 8, taken alone, however, the towers are the principal features, taken as a group of two, with the two-story porch between as a connecting link.

19. Now, to sum up these rules for grouping, we have in Fig. 9, a group of one, at (*a*), showing the force and

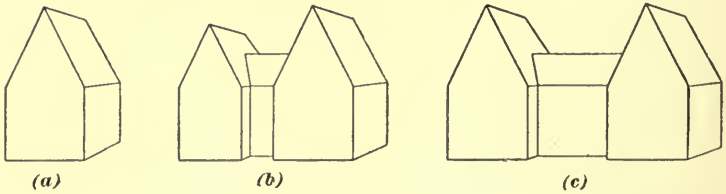


FIG. 9.

strength of an object which is designed to stand out by itself, independent of all surroundings.

At (*b*) is shown a group of two unequal objects, connected by an insignificant link which serves only to unite the two members of the group. Here the attention is first arrested by the larger gable, and the mind then gradually relaxes and receives the impression of the whole mass as an object in *unity*.

Next we have, at (*c*), a group of two equal objects connected by a link which in this case must be more prominent than in the previous example. Where the group is of unequal objects, it is sometimes desirable to bring them close together in order that their inequality may be more pronounced. Especially is this the case when the difference in mass is not very great. When the objects are the same size, however, it is well to separate them somewhat, as there is no occasion to compare one with the other; and should

there be a slight inequality, either of form or detail, the separation will assist in subduing it.

20. In a group of three we have the same rules to follow, though the problem is slightly more complex, and in some cases taxes the designer's ingenuity to a greater extent. At (*a*) in Fig. 10 is shown a group of three unequal

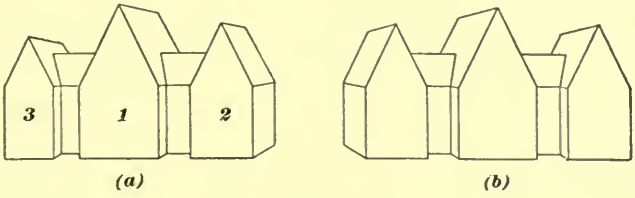


FIG. 10.

objects; the largest one is in the center, the second one on the right, and the smallest one on the left. Now this is the most logical arrangement for this point of view. The greatest mass is in the center, where it should be; while the lesser object is nearer the eye, where it appears in its true size. The smallest object is the most distant where the effect of perspective is to make it contrast more strongly with the central object and at the same time remain subordinate to the secondary mass. If the smallest object were nearest the eye, the effect of the perspective might tend to make the two ends at first appear symmetrical, which closer study would afterwards prove to be false, and the repose of the composition would thereby be likely to become uncertain. Masses *1* and *3* should be placed somewhat closer together than *1* and *2*, as in order to establish a feeling of balance it is not well to have too much material on either side of the center line. If circumstances compel *1* and *2* to be close together, then balance may be preserved by carrying *3* still farther away and emphasizing the lack of symmetry instead of trying to hide it. Under such circumstances, however, it is usually better to assemble *1* and *2* as a single mass and treat the entire composition as a group of two. If the group is to be viewed from both the left and the right, so that either the smallest or the second mass is nearest the eye, then the

balance may be maintained by keeping *3* and *1* closer together than *1* and *2*, thus emphasizing the diminutiveness of *3* without affecting the size of *2*, except by perspective.

The group (*b*) shows a symmetrical group of three with the masses equally spaced and the largest object in the center. This is an imperative arrangement for such a group, and any deviation is likely to throw it out of balance.

21. Equal but dissimilar objects should never be grouped. In Fig. 11 at (*a*) is shown a group of two dissimilar schemes of roof treatment. The effect is very

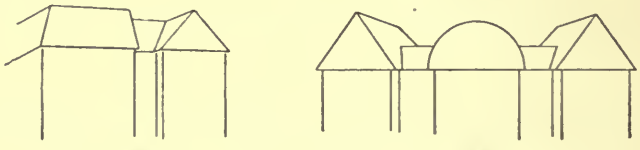


FIG. 11.

unpleasant, as there is much uncertainty as to which detail is the more important. If they were alike, there would be no such feeling, as the one would possess as much value in the composition as the other, and they would harmonize; but as it is they stand in competition, thereby destroying not only harmony and repose, but also balance and symmetry. At (*b*) is shown a group of three equal and dissimilar objects, and though the effect is not as bad as in the previous case, it is a combination to be avoided, as it can never be made to yield satisfactory results.

22. This leads us to a scheme of design which may be termed *double composition*. This may be described as that character of composition which joins in one design two dissimilar objects which are not pleasing. One of the worst forms of double composition is that of a pair of arches whose outer abutments rest on masonry walls, and whose joint inner abutments are supported by a single column. In any group of three members, the central one must be made much the largest, if it differs in shape from the other two. Many prominent buildings are designed with a small central detail,

flanked by large masses quite different in character. Such compositions, to be successful, must have the flanking masses so large that it is evident that a group of two, and not of three, is intended.

23. A group of four or more members is never satisfactory, and where there are more than three principal objects in a composition, they should be assembled in minor groups of from one to three details, and so treated that the general effect is of a group of two or three.

Fig. 12 illustrates this scheme of composition. Masses *3* and *4* are assembled to form a minor group which balances group *2* on the opposite side of the predominating mass in the middle. In this manner almost any number of objects may be harmonized in an apparently double or triple group; and the designer thus has before him an object towards which he can systematically work, and a definite idea of the theoretical requirements which his problem in design demands shall be fulfilled. This is the proper method to secure satisfactory results in double grouping, and it should be borne well in mind that, whether the objects are equal or unequal, the members in each group must always be alike. In triple grouping, the central member must be much the largest, or the three members of the group must be alike; and finally, in any group of many members, one should be much the largest, and the others must fall together in subordinate groups of two or three.

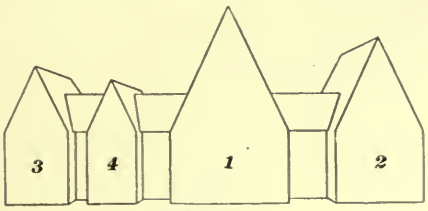


FIG. 12.

INTERIOR ARRANGEMENT.

24. While composing the design of a building, and while studying each part of the plan, the possibilities of the resulting whole must be kept vividly in mind. The plan itself must not absorb all of our attention, but must be considered

as a mere incident of the whole design. It is simply a horizontal section of the building, and bears to the entire structure a relation no more important than the longitudinal or transverse section; it is, however, the source of much comfort or discomfort to the occupants of the building, and the general adjustment and arrangement of the apartments should be primarily and at all times governed by considerations of convenience.

Too often the plan is given precedence in the matter of importance over all other sections, but a satisfactory whole can only be secured by duly studying each and every section which pertains to the composition. Considered as a working drawing, the plan is indispensable, the vertical sections being of secondary importance; but that is no reason why the latter should be relegated to an inferior place as objects of serious study in the composition, while the plan itself monopolizes all the thought and ingenuity at the designer's command. Too frequently the plan and the visible portions of the structure erected upon it are studied separately and independently. The exterior is fitted to the plan as best it may be, instead of growing out of it as a natural result. By having our thoughts led away from the plan to the building itself, we shall be less likely to start designs which do not work up well, and, instead of having to fit our elevations to our plans, we will find them growing out naturally and easily, because, while studying the plan, we have been mentally evolving the whole.

The successful design is produced only when the plans, elevations, and vertical sections are carried along together, and when the preliminary design has been sketched in the mass, and all details have been left for subsequent elaboration. Then, when the preliminary block plan, elevation, and section are determined, the large-scale studies may be started; and, as before, they should be carried on together, so that the consequences of any change in one may be readily noted in each of the others.

Constant tracing and retracing of every part of the design, in order to study the effect of every possible modification of

it upon each other part and upon the whole, is the rule of practice in the offices of all the best architects.

25. The plan has a number of predetermined dimensions, such as the thickness of the walls and the size and grouping of the piers; it is also, more than any other section, affected by considerations of use and convenience; the relative position, size, disposition, and arrangement of rooms, halls, stairs, fireplaces, etc. must be determined in the plan; but it is as great as it is a common mistake to imagine that only convenience and utility are to be here considered; for the artistic value of every structure depends, or should depend, as much upon its plan as upon its elevation. This will be readily seen after starting the sketch plans and elevations, especially if we make frequent sketches in perspective of interior as well as exterior arrangements. Thus, we can keep before us the relative proportion of all the rooms and apartments, and we must keep that proportion in mind throughout all our sections and elevations, for the changing of the height of the ceiling in a room makes a vast difference, and we must, if possible, ascertain the relations desirable between all three dimensions of every important room. The greater its importance, the more careful the study required. While we are proportioning the length to the breadth, we must bear in mind the proposed height of the room, in order not to have it of awkward proportions; so that we see now that it is in the designing of the plan that all of these have to be considered. In order to change the apparent dimensions of a room, we may introduce *pilasters*, and these must be shown in the plan, as they will have a great influence in the spacing of doors and windows. Or we may have to change the actual dimensions, and so start a series of alterations that may revolutionize the whole plan. Not only do the proportions and actual size of each room require careful study from the esthetic point of view, with the constant exercise of the pictorial imagination, but the very shapes, positions, and sizes of the rooms, relatively to each other, must be subjects of design.

26. Another question of esthetics is that of the *sequence of forms*. Nothing is more wearisome or monotonous than a series of rooms all of the same size or shape. Variety is indispensable to artistic excellence, and the arrangement and succession of rooms of different forms and proportions is a very important element in producing emotions of pleasure, whether the structure is a cottage or a club house, a mansion or a museum; while in strictly monumental work of a religious or civic character, the proper succession of aisles, chapels, and bays, or of reception rooms, parlors, and vestibules, taxes the highest artistic resources of the designer. A most interesting example of this is the Borghese Palace, at Rome, where, owing to the angular direction of the two streets on which the palace is built, the rooms are a succession of trapezoidal apartments, diminishing towards the narrow end of the building until the last room is scarcely more than a closet. The necessarily irregular shape of the rooms is responsible for their awkwardness and lack of dignity. But the character of the structure is rescued by the skill of the architect in drawing an axis through the whole range from end to end, upon which a broad door opens into each successive room, and the long vista produces an air of grandeur that entirely redeems the insignificance of the trapezoidal forms. The Hotel du Maine, at Paris, Fig. 13, is another good example of the wise use of axial lines in laying out a plan, as well as a proper consideration of the necessity of a pleasing variety and sequence of forms.

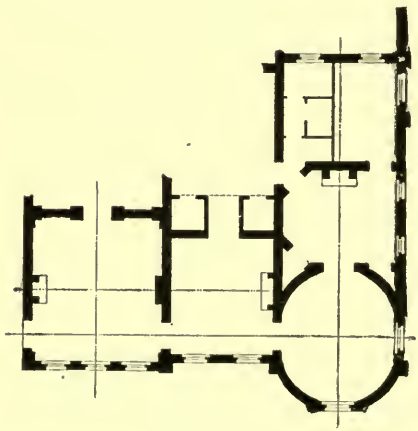


FIG. 13.

27. First of all, a positive excellence to be aimed at in all planning is *simplicity*. Complication and irregularity of plan are not evidences of

ingenuity, but the reverse. It requires the highest art and skill to perfectly satisfy all the complex needs of an important building, by a plan that appears to the eye, on paper, to be laid out on the simplest and most obvious lines, free from artifices and makeshifts, all parts fitting perfectly into each other in simple and orderly combination.

It is to be noticed that the best arranged and most orderly plans, and those most productive of powerful effect in execution, are precisely those which on paper appear the simplest.

Observe the plans of such widely differing structures, erected at such widely separated ages, as the Parthenon (see Fig. 18, *History of Architecture*); Hagia Sophia, Fig. 43; the medieval cathedrals, Fig. 76; and the Renaissance palaces, Fig. 116. The simplicity of the scheme by which such varied and complex parts are combined, will immediately command attention.

28. Another excellence, to be obtained if possible in every plan, is *symmetry*. This term in design has sometimes been understood to mean that one-half of the plan should be the exact counterpart of the other half, and that to this requirement every other must be subdued. This definition, however, relates only to axial symmetry, and explains only a portion of the value of the term.

The approach to such symmetry, both externally and internally, is pleasing and satisfactory; while the absence of it, unless compensated either by very skilful *balance* in the design or by the independent symmetry of each portion of the mass constituting the whole, is invariably unpleasing and disappointing.

Upon the Acropolis at Athens (Fig. 29, *History of Architecture*) stand two most conspicuous examples of symmetry: the Parthenon, whose four elevations are all symmetrical, and the Erechtheum, which is composed of three parts, differing in design, level, and dimension, but with each of the three perfectly symmetrical in itself, and so appropriately placed as to compensate entirely for the lack of the geometrical symmetry of the mass.

Where symmetry is impossible, balance may be practicable. That is, one feature of a plan or an elevation may be balanced, not by an exact counterpart on the other side of the central axis, but by another feature of equal importance though of entirely different form. For instance, in a monumental hall, a staircase may occupy one side and be balanced on the other side by a handsome group of statuary. And then again, when neither symmetry nor balance can be attained, it is generally desirable to emphasize the unsymmetry and establish a balance on some other axis of the plan.

29. This subject of *axes* is of much more importance than is generally supposed. We are more familiar with their importance in the elevation where the placing of one part above the axial line of another, or the balancing of the window openings on each side of the doorway is generally desirable, but we do not as a rule give it proper attention in the plan. The distinguishing characteristic of many American dwelling houses is the irregularity of their plans, and although this sometimes leads to picturesque effects, it is by no means a result to which good planning should be sacrificed. Many a plan from which geometrical symmetry and balance are wanting, acquires dignity and a certain air of fitness and order from the proper use of axes in laying out certain features in the arrangement.

30. Before considering further the details in the arrangement of plans, let us be clear in our understanding of the meaning of what is called a *monumental plan.* This term is not applied to monuments alone, nor even to buildings that are intended to be monumental in size or purpose; nor yet because the plan of a building covers a large area. A monumental plan is one that produces no impression of restraint or limitation in any part. Largeness of parts, simplicity of arrangement, and general outline, and combinations that make most of the space and dimensions available, produce the monumental effect. Nothing can well be imagined more

monumental than the Pantheon at Rome (see Fig. 32, *History of Architecture*), while a plan such as shown in Fig. 14, which is cut up into many small parts, complicated by many corners, nooks, and recesses, conveys an impression which is

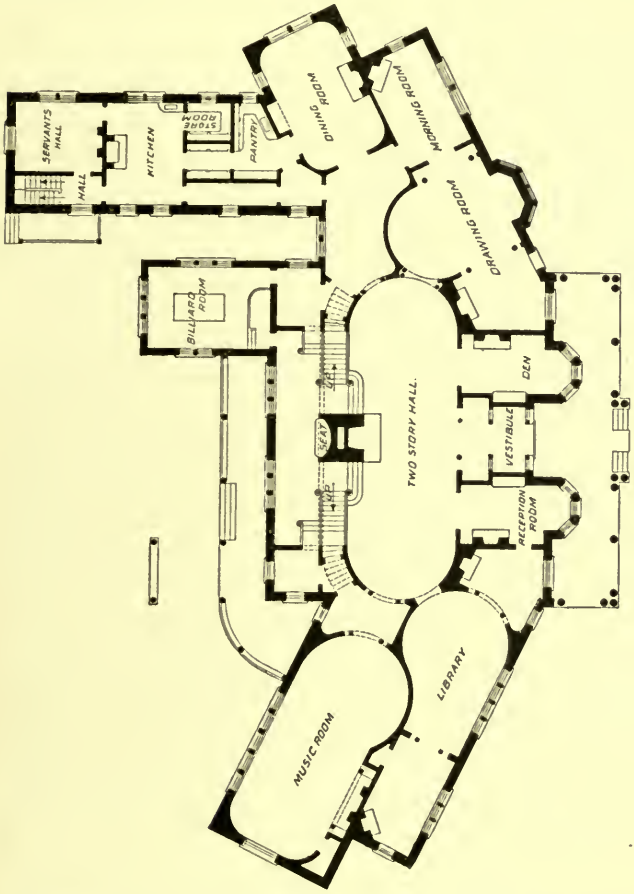


FIG. 14.

anything but monumental in its nature. Moreover, it is not sufficient that the larger and more important divisions of the plan shall be made spacious and impressive; the entrances, approaches, stairways, and halls are nearly as important. These the public throng most, and if first impressions count

for anything, it is important that these features shall appear generously conceived and liberal in their dimensions. The different impressions felt on entering French and English cathedrals are largely due to the superior size, depth, and grandeur of the French cathedral porches, compared with the trivial openings that admit one to the English churches.

The portico of the Roman Pantheon is a fit introduction to the majesty of its interior. The great narthex of Hagia Sophia is a worthy vestibule to the greater splendor and loftier beauty of the Byzantine dome. These considerations apply not only to public buildings, but also to those private buildings which aim at amplitude and dignity, rather than coziness and seclusion.

The public buildings of Europe show that great care and study has been bestowed upon these distinctive features; a generous allowance of space has been assigned to them that is too sadly wanting in buildings of the same class in America. There are, however, a few notable exceptions, but they exist mostly in hotels and apartment houses, and not in the municipal or government buildings. Throughout France there is hardly a town that does not possess one or more buildings that would put to shame, by the dignity and impressiveness of their entrances and stairways, many of the most pretentious public buildings in America.

No innovation in American domestic architecture has created such a favorable impression, as a feature in house planning, as the modern idea of converting the entrance hall into a reception room, with wide, elegant stairs, plenty of space, and cheerful furnishings, instead of the narrow tunnel-like passageway, half blocked by a narrower stairway (constituting an apartment suggestive of little welcome to the visitor), which we witness in many of the houses erected a generation ago. But it certainly would be inconsistent to give the hall and stairway the sole benefit of our resources in ingenuity of arrangement and design, leaving the principal rooms and main features of the plan simply rectangular. A room which is merely a square box can never be monumental, whatever may be its size, and what can be

done to make it so depends entirely on the merits of the case.

The proper grouping and arrangement of the doors and windows will produce the desired effect in one case, while, under other circumstances, pilasters, ceiling beams and cornices, and niches arranged in the walls, will impart a richness and dignity to the bare rectangle; or the bare walls may be left for frescoes or painted decorations, of whose character we need not concern ourselves, while scheming out the plan.

The modern resources of iron beams, stud partitions, and hollow brick, tempt us to design the upper stories independent of those immediately below, and to arrange rooms and to place partitions as seems to be most convenient, without regard to those in adjacent stories. Such a course, however, cannot be too strongly condemned; being structurally defective, no satisfactory results can ensue, while skilful adjustment, which constitutes the art of planning, is at once evinced by successfully harmonizing the requirements of the different stories in such a manner that the principal divisions shall be the same throughout, and thus be constructed as continuous partitions, while the subdivisions formed by partitions which are not continuous shall be as few as possible.

This is of great importance for other reasons than that of stability; pipes, flues, wiring tubes, etc. are run from one floor to another through the heart of the partitions, and unless the partitions are placed immediately one over another, undesirable offsets are formed in the pipe or flue lines, which materially reduce their efficiency.

EXTERIOR TREATMENT.

31. If the plans have been studied with constant regard to the resulting whole, the form of the exterior will be already determined in some of its broadest features, before a line of the elevations has been drawn. The width and depth of all

the projections and wings, the general arrangement of the wall openings, and to a certain extent the form of the roof, are already determined provisionally by the arrangement of the plan. They are the first limitations that govern the exterior design; limitations that may be modified, however, but always at a cost of a change in plan. And yet such changes in plan *must* be frequently made in order to arrive at the best solution of the problem under consideration. Patience, perseverance, and courage to constantly alter and realter different parts of the design that may be unsatisfactory, are attributes of the character of the true architect who is successful in his works. In designing, we must always be ready to retrace every step again and again until the result fulfils the complete limit of our requirements. The resources at our command that contribute to the expression of artistic taste in our designs, are: (1) *Outline of mass;* (2) *proportion of parts;* (3) *distribution of voids and solids;* (4) *light and shade;* (5) *ornament and color.* The demands of beauty require graceful and elegant forms well suited to the purpose for which they are intended, and appropriately expressive of the reason for their existence. In a perfect building, all of these resources are made use of, and are so arranged, adjusted, and blended that each and every detail harmonizes with each and every other detail, as well as with the whole composition of which they form a part, and its character betokens a repose which can only be secured when reason and beauty are in unison.

If we carefully examine the famous buildings of all ages, we will discover that these resources range in importance practically in the order above given.

32. The fundamental beauty of a noble building—the mental picture of it which we carry with us—is the outline of its mass. The beauty of this outline appeals to us alike in the Parthenon at Athens, the Pantheon at Paris, or St. Paul's in London, and is totally independent of the decoration of these structures. If the modeling of the masses which enter into the composition has been well proportioned,

we will invariably carry a pleasant memory of the beauty of a building in our mind, even though the decoration and detail is incongruous and inappropriate.

Light and shadow impart dignity or variety to a composition. They are a most powerful means of producing beauty, yet they are wasted if the structure has not been carefully modeled and its parts duly balanced. Many very beautiful buildings present a large area to the light without having a single shadow of importance, while others, equally beautiful, derive their beauty very largely from the play of light and shadow over their breaks and cornices.

The Strozzi Palace (Fig. 89, *History of Architecture*) is an example of the former class, its entire facade being unbroken by any prominent projections except the cornice surmounting the whole. This building depends for its architectural effect upon the dignity of its mass; the insignificant shadows cast by the projections of its ashlar, and by the recession of its windows, being scarcely noticeable in the broad expanse of the front. The heavy projecting cornice was here necessary to contrast the simplicity of the front. Had it been designed with less boldness, it would have suggested simply a horizontal belt course on a partly finished building, and it was, therefore, necessary to emphasize its projection beyond the possibility of mistaking it for anything else than the overhang of the roof. The Strozzi is one of the noblest palaces in Italy, and is worthy of close study on account of the simplicity with which this grandeur is obtained. In contrast to this are the structures of the early French Renaissance (see Figs. 98 and 99, *History of Architecture*), dependent for their beauty entirely upon the varied play of light and shadow of the numerous projections and pinnacles scattered through their composition.

The distribution, form, size, and grouping of the voids and solids is equally important, and is somewhat related to light and shade by interspersing small areas of darkness amid the brightness of the illuminated areas of wall surface. By them and their arrangement, whatever the proportions, the whole building is made monotonous or varied in its composition.

According to this distribution of voids and solids, and the arrangement of its high lights and shadows, the structure becomes graceful, dignified, light, and winning, like the chateaux along the Loire (see Figs. 98 and 99, *History of Architecture*), or stern and strong, like the Palazzo Vecchio, in Florence, shown in Fig. 80, *History of Architecture.*

33. Ornament should be used as an adornment to what is already beautiful, as it can benefit an ignoble building only by drawing attention away from the glaring faults of the building itself. All the resources of design we have so far considered concern the form of either the various parts of a building or the entire structure; but now we reach the lowest kind of architectural beauty—that of *color*—color, the element in which the entire animal creation, the savage, and the infant rejoice, though blind to all other beauty in art.

Color, nevertheless, is the most sublime and widely diffused phase of beauty in the whole natural creation, the loveliness of nature seeming to depend on it even more than on form. But no splendor of color can impart other than a superficial and wholly meretricious sort of beauty to mean and unbeautiful architecture. It may be used to enhance it, but must always be subordinate to the artistic resources mentioned above.

34. The order of importance of the *elements of beauty* in *external* architecture is the reverse of their obviousness. The more subtle and refined these elements of beauty are, the more difficult they are to discern and understand—the less apparent and obvious they become to the senses.

The beauty of the Parthenon (Fig. 20, *History of Architecture*) is of a type far higher than that of the Paris Opera House (Fig. 129, *History of Architecture*); but the splendor and elaborate decoration of the latter attracts the attention and captivates the minds of those incapable of appreciating the exquisite refinement of line and proportion in the Attic temple.

Popular taste delights far more in extravagant and excessive detail than it does in noble proportions and refinement

of outline, but even the uneducated tourist will carry a clearer and more accurate conception of the beauties of the Grecian temple than he will of the Milan Cathedral, because the beauties of the former are those of proportion, and because its every part is full of that higher beauty of refinement which does not reveal itself at once and cannot be fathomed by a casual observance. The tendency of the present age requires us to dwell upon these truths, to emphasize the value of the principles which produce them, which are so easily forgotten in the vulgar rage for bric-à-brac and detail, and to impress the fact that architectural beauty is in the form of the whole mass, and if the mass is not well proportioned and refined in outline, all the detail in the world will not make it a pleasing building. There are today a hundred good designers of detail and ornament to one who can compose a good elevation or lay out a rational plan.

In the streets of our great cities are hundreds of buildings whose details and ornaments are excellent; but few municipal communities can boast a dozen edifices that possess these higher attributes of beautiful outline and perfect proportion.

In ordinary street architecture there is much less scope for the study of mass than in detached monumental buildings, but elegance of proportion is no less important to secure. When one is hampered by the restrictions of a 25-foot lot for a seven-story building, the problem is a difficult one, but by no means hopeless. Well placed string-courses throughout the height, the emphasizing of just the right amount of horizontal members, the grouping and proportioning of windows so as to give the greatest amount of breadth and dignity to the whole, are all resources to be utilized by the true artist, but which are sure of misuse by any designer destitute of a keen sense of proportion. By breadth and dignity is meant that quality in a design which causes the eye to gather in the entire general effect of the building, and not be arrested by the prominence of some particular detail or projection.

35. There are few works of architecture in which the beauty of the structure is so entirely embodied in their

correct proportions, apart from any detail or decoration, as the palaces of the Roman Renaissance. Here, too, the charm of picturesque variety and strong shadow is also advantageously displayed. The palaces of Florence and Sienna are, most of them, too sombre and fortress-like; while those of Genoa are, many of them, lacking in correct proportions and distribution of parts. But the buildings of Rome, of the Renaissance period, charm one with the mere grace of proportion and distribution.

With a few columns and pilasters, or a simple cornice, and two or three well placed belt courses, with windows well devised, and elegantly spaced, in stories whose heights have evidently been most carefully studied and proportioned, without carving or ornament, without a break in the flatness of the front wall, these palaces are beautiful, and one never tires of looking at them. This same noble quality is found in all good architecture, but is too often hidden more or less by richness of ornament and extreme variety of light and shade, which appeal to the senses more quickly than does excellence of proportion, and often receives credit for the architectural beauty which in reality lies behind them in the proportion and mass of the building itself.

The Farnese Palace (Fig. 94, *History of Architecture*) is a fair example of the value of the qualities above referred to. The entire facade is made pleasing and restful, simply by the refined proportion of its parts and the simplicity of the design.

The same may be said of an entirely different structure, the Palace Contarini, in Venice (Fig. 83, *History of Architecture*). It is a narrow facade with but three windows in each story; aside from its beautifully carved balconies, it is full of suggestions to modern house designers, on account of the fine proportions of the facade, and the skill with which the openings are managed.

Sometimes, the best way of producing nobility of effect is to emphasize some one dimension, especially where a too delicate adjustment of the three principal dimensions would tend to belittle a really good design. The architects of the

French cathedrals produced majesty by the great height of the nave, while the English designers secured the same effect by making the nave of great length; and both examples, by the grandeur of their results, show the value of such accentuation of one dimension while keeping the other two within moderate limits. The architects of the great Greek temples, exaggerating neither one over the other dimension, produced a beauty of the most perfect type by the harmony of all three.

Which of these courses to follow, every architect must choose for himself, but the decision must not be determined by chance, but must be the result of mature consideration.

36. Next to proportion comes light and shade, and, also, the distribution of voids and solids, which may be made to minister to fine proportion or be its ruin. These concern the features of the building. They determine the use and arrangement of cornices, entablatures, string-courses and moldings, projections and recessions, piers, columns, pilasters, doors, windows, and loggias (or covered external galleries, especially in upper stories).

The fact that many of these features are largely conditioned by the plan, only makes it more imperative to study the plan with the resulting elevations constantly in the mind's eye, and to keep its final form in suspense until the requirements of the exterior are fully determined. Thus only can the projections, balconies, loggias, doors, windows, etc. be so distributed as to produce on the exterior the desired effect. The Gothic builders understood this, and depending on light and shade for architectural effect, their plans are so designed as to make these effects possible. The exteriors of medieval buildings, both secular and religious, are full of movement and variety. They sparkle with the play of light and shadow in vertical lines, cast by buttresses, piers, and pinnacles, and the shaft jambs of the tall windows. To give them greater animation, crockets and finials were introduced, catching the light in brilliant points and casting fanciful and serrated shadows, while tall pinnacles

outline themselves against the dark roofs of slate or copper.

In Classic and Renaissance buildings the vertical shadows are few or slight, and the strong horizontal shadows of cornices and string-courses predominate. The openings are fewer, but are wider and larger, and broad areas of solid wall give majesty and repose to the whole conception.

37. From the preceding it will be seen that the great fundamental quality underlying all architectural structures is *proportion*—proportions of masses and proportions of details, and proportions of details to masses. Different architectural epochs had different systems of proportion, and each age was artistically a success or a failure directly as this system was positive or arbitrary. The Greeks had a system of proportion more refined than anything since discovered. It was based upon mathematical relations so subtle that the true secret of its workings has never been entirely elucidated. Nevertheless, every Grecian monument proclaims emphatically to the analytical student that each line of its mass and each detail of its composition is proportioned by a method as perfect as it is obscure.

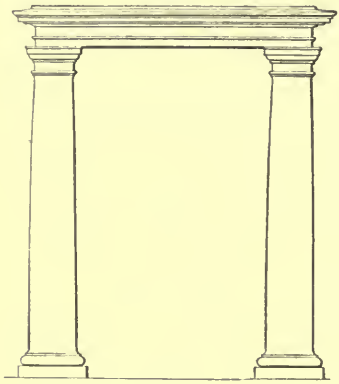


FIG. 15.

The Gothic builders had a system, based upon geometrical motives, and the grand cathedrals of the thirteenth century stand today as monuments of its perfection. The Renaissance age had no fixed system of proportion peculiar to itself, but modeled its structures on the supposed system of the ancients; we consequently see a varied lot of edifices scattered over Europe, which, beautiful though many of them are, stand more as monuments of lack of comprehension of the purpose of classic forms than of appreciation of the value of a perfect system of proportion.

It is, therefore, necessary that the architectural student should familiarize himself with the idea of proportion from the very beginning of his studies, and every drawing he makes should leave with him some permanent mental impression of the proportion of its parts to its whole.

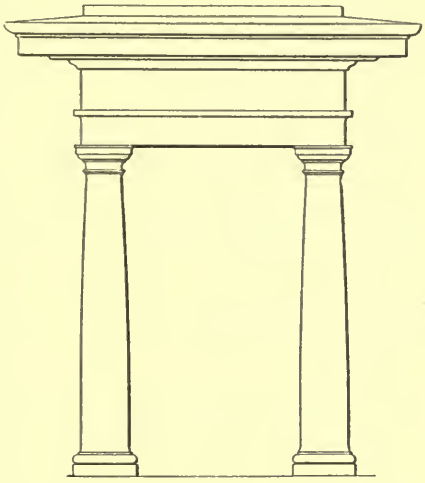


FIG. 16.

38. No absolute rules can be laid down which will govern all cases of proportion. Practice, experience, and inherent good taste are the only means of securing the most desirable relations between the different parts of a building. A glance at Fig. 15 is sufficient for one to discover that the entablature is far too small and light for the columns supporting it, and looks pinched and ridiculous. Fig. 16, on the contrary, shows a pair of columns carrying an enormously heavy entablature, as much too large as that in Fig. 15 is too small.

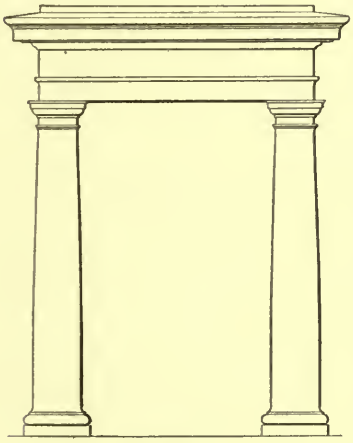


FIG. 17.

These errors of proportion are appreciable to the eye, and in no way require mechanical measurement to verify them. It is, therefore, evident that a well proportioned entablature will be considerably larger than that in Fig. 15, and much smaller than that shown in Fig. 16, and if the eye is well trained it will discover the proper proportions in Fig. 17.

The nearer we approach the exactness shown in Fig. 17, the more difficult and delicate is the task of discovering unaided by mechanical measurements any discrepancy in proportion; but by practice and experience the eye will become so trained that it will discern these discrepancies at a glance, and in composing an architectural design the judgment of the trained eye is worth all the mathematics ever invented. However, in order to acquire this training, we must study such architectural forms as will permit a mathematical analysis from this standpoint.

CLASSIC STANDARDS OF PROPORTION.

THE FIVE ORDERS OF ARCHITECTURE.

39. The orders, heretofore so frequently referred to, furnish us with a standard of proportion with which we can measure all the classic monuments, and by which the work of the Renaissance was, and much of the modern architecture is still proportioned.

As we have already seen, the structures of the classic ages were nearly all columnar—either with lintels connecting the tops of the columns as the Greeks built, or with arches, according to the Roman custom. Now, the architects of the classic ages had reduced to an exact *system* the proportions of length to thickness in columnar work, and down to the present day we have been unable to improve on their proportions, and have followed them as closely as did their admirers of the Renaissance period. This system is universally known as the "Five Orders of Architecture," and it embraces every combination of lines and masses seen in the classic monuments.

In it we find the fundamental principles of proportion, and only by the most careful study of these principles can we advance in our studies of architecture as a fine art.

40. In its architectural meaning the term **order** refers to the system of columniation practised by the Greeks and

Romans, and is employed to denote the column and entablature together—that is to say, the upright supporting piers, and the horizontal roof beams or *trabeation* supported by them. These two divisions constitute an order, and so far all orders are alike; but the form and proportions of the subdivisions of both the column and the entablature, make it necessary to divide the original Greek orders into three classes, and when these three were adopted by the Romans, they again divided two of them, making five in all. Hence, it has become proper to refer to the *Five Orders of Architecture*, including the entire list. The three original orders of the Greeks are the Doric, Ionic, and Corinthian, as explained in *History of Architecture*. Each order is an assemblage of parts subject to uniform, established proportions, and is regulated by the office each part has to perform. This so called "assemblage of parts" refers to the base, shaft, capital, architrave, frieze, etc., while the "uniform, established proportions" are the comparative sizes of these parts to each other in the same order. "The office each part has to perform" governs its size, shape, and position, and thus completes the expression of character in the order.

41. The general character of the Grecian-Doric order is expressive of grandeur, dignity, and simplicity. Hence, we find it used almost exclusively in such temples as are dedicated to the most revered of the Grecian deities, such as the Temple of Zeus, at Ægina, and the Parthenon, at Athens. This is the most ancient of all the classic orders, and the proportions of its parts vary considerably in the different periods of its history. However, it reached the zenith of its perfection in the Parthenon, and it is from the portico of that temple we take the example illustrated in drawing plate entitled, Grecian Doric, in *Advanced Architectural Drawing*. It has already been observed that the Grecian-Doric column consists only of the shaft *B* and the capital *C*, which latter is composed merely of an *echinus* and an *abacus;* the first being a convex molding spreading out from the top of the column beneath the other member,

which, though being a very important one, is no more than a plain square slab upon which the architrave *D* rests. The Grecian-Doric order never possesses a base, but stands upon a stylobate *A*, which is the substructure or foundation usually disposed in three steps or divisions that extend entirely around the building, and by spreading the ground line of the structure give a proper feeling of solidity and support. In the outline of the column we first observe contraction and then expansion; the former where the echinus converges to the neck of the column, and the latter where the column swells out to form a firm and substantial support at the bottom which is larger than the top. With few exceptions, the column of the Grecian-Doric order is fluted; that is, its surface is grooved perpendicularly by a series of concave channels which touch each other and form a series of ridges, or *arrises*, upon its surface—a mode of decoration which is the direct opposite of that practised by the Egyptians, some of whose columns exhibit, not channels, but a series of convex shafts like a bunch of reeds or stems bound together. In the Doric order, the number of channels is either sixteen or twenty, and in the other orders there are usually twenty-four, and though the number varies, it is invariably divisible by four. The reason for this is to be found in the probable evolution of round columns from square piers, as explained in *History of Architecture*.

Doric flutings are much broader and shallower than those of the Ionic or Corinthian orders—broader for two reasons: first, because they are fewer in number, and, therefore, divide the circumference into larger parts; and, second, because there are no separating fillets between them. The shallowness of the Doric flutes is due to the fact that the arrises, or edges where the flutes come together, would be thin and liable to breakage if the flutes were deeply cut. This manner of fluting Doric columns, leaving arrises between the grooves instead of fillets, has been retained in modern practice as one of the characteristics of the order. In the Grecian Doric, every detail is marked by its breadth or flatness, or by its sharpness. There are no curved moldings

or surfaces except the *epitithedas*, a term given to the uppermost member of the corona and the echinus, the latter being almost flat on its under side and finished with a sharp turn against the abacus. The breadth and shallowness of the channels, and the flat curves in which they are formed, are, therefore, in perfect keeping with the style, as are also the sharp arrises between the flutings, which are expressive of a severe simplicity. The horizontal rings, or *annulets*—mere grooves cut around the neck of the column to separate the capital from the shaft—are again expressive of the extremest simplicity, and are in direct contrast to the projecting astragal, or convex molding, of the Doric capital as modified by the Romans.

The echinus is a simple convex molding, from its shape often called a thumb molding. Its form is suggestive of strength as it expands to connect the diminished upper end of the column with the overhanging abacus.

42. The entablature of the Doric order is, like the column, the embodiment of dignity and simplicity. Its lowest division, the *architrave D*, is a plain beam, whose height including the tænia, or fillet, is a trifle less than the upper diameter of the column. The middle division, or *frieze E*, constitutes a very characteristic feature of the Doric order, being invariably ornamented with its *triglyphs* and *metopes*. The former of these consists of upright blocks about one-half the width of the mean diameter of the column, having their faces grooved with two **V**-shaped channels, and their edges chamfered off with two half channels, thus making three channels altogether, from which the ornament derives its name of triglyph, or three-channeled. A portion of the triglyph, called the fillet, extends below the tænia, and depending from it are six drops, or guttæ, which represent the heads of trenails or pins used in the early wood construction.

In regard to the arrangement of the triglyphs, one was placed over every column, and one or more over the space between each pair of columns, but always so spaced that

the metopes, or spaces between the triglyphs, should be exactly square; in other words, the height of the triglyphs is equal to the distance between them. In the best Greek work there is only one triglyph between each pair of columns, and this arrangement is usually called *monotriglyphic*, or single-triglyphed intercolumniation. A peculiarity of the Grecian-Doric frieze is that the end triglyphs, instead of being, like the others, in the same axis, or central line, as the columns beneath, are placed quite up to the edge or outer angle of the frieze; this is accomplished by making the extreme intercolumniations less by one-half a triglyph than the intermediate ones, thereby imparting an expression of strength to the angles of the building.

The triglyphs are thus seen to govern the spacing of the columns, and as the spacing or intercolumniation governs the diameter, and the diameter governs the height, etc., we see that nearly all the proportions of a Doric temple can be traced from the size of its triglyph. There is one exception to this, however, and that is the little choragic monument of Thrasyllus, on the south slope of the Acropolis, at Athens. This monument has no triglyphs, but a series of wreaths ornament the frieze in their stead. The guttæ are nevertheless retained, but instead of being grouped at intervals, they are continued across

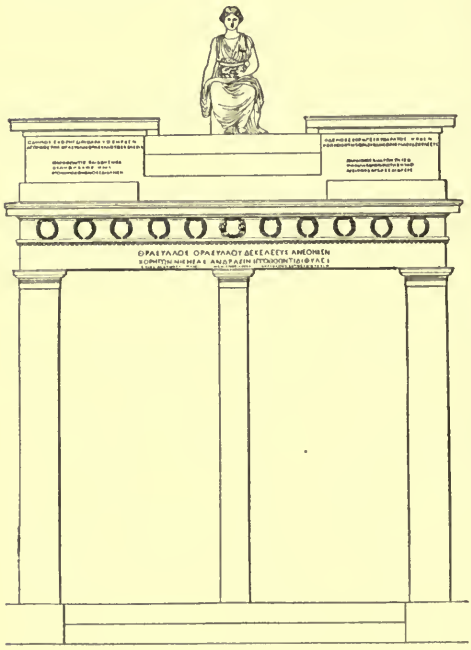


FIG. 18.

the lower side of the tænia uninterruptedly, as shown in Fig. 18.

43. The third and last division of the Doric entablature, the *cornice F*, though extremely simple, is strongly characteristic and boldly marked. It is in height about two-thirds the height of the frieze, and it is divided into three principal parts, the *corona*, with the *mutules* beneath it, and the *echinus* above it. The mutules are thin plates or tablets worked on the *soffit*, or under side, of the corona, directly over each triglyph and each metope. With the former they correspond in width, and their soffits, or under surfaces, are set with a *rake*, or slant, which makes them parallel with the line of the pediment. They represent the under side of the wood roof beams which extended over the eaves in the earlier construction. Three rows of *guttæ*, or drops, somewhat conical in shape, ornament the soffits of the mutules, and each row corresponds in number of drops with the guttæ on the triglyphs beneath. These guttæ are shown in the plan of the under side of the cornice, Fig. 5 of this plate, where three rows, with six drops in each row, are shown within the outlines of the plan of each mutule. Here, also, is seen a section through the triglyph at the angle, and the V-shaped channels are shown in the face of the triglyph.

The *corona* is merely a boldly projecting flat member not much deeper than the abacus of the capital, although examples exist where it is even less.

The uppermost member of the entablature, the *epitithedas*, is sometimes a *cymatium*, or *wavy* molding, convex below and concave above, or it is an echinus similar in profile to the echinus of the capital. The cornice is to the entablature what the capital is to the column, the crowning member of the composition, completing and ending it in a very artistic and pleasing manner. In Fig. 1 is shown a plan of the column at its base, where the flutes and arrises are more clearly defined. In Fig. 2 is an enlarged elevation of the capital of the Doric column, where the echinus is shown continued in a dotted line up into the abacus. The purpose of this, as

well as the method used by the Grecian artists to form the contour of their moldings and other details, will be described further on when we enter into the discussion of classic moldings.

44. Antæ.—Pilasters, as well as columns, may be considered to belong to an order, and in modern practice are frequently substituted indifferently for columns, where the latter would be engaged or attached to a wall. In Grecian architecture, however, the antæ are never so employed. They are never placed consecutively or in series, but always as a facing at the end of a projecting wall, as shown in Fig. 17, *History of Architecture*. Although the antæ are used in company with columns, they differ widely from them, as the shafts are never diminished, and the capitals are in no way similar to the caps of the accompanying columns.

The capitals of the antæ, Fig. 19, are composed of one or more slightly projecting facias *a*, above which is a molded abacus *b*, supported on an irregular molding which is hollowed out below, to form in section what is known as a *bird's beak c*. Below this bird's beak are a number of projecting fillets *d*, similar to the annulets on the Doric column. In a portico *in antis*, the want of greater harmony between the antæ and the columns is compensated by the contrasts. Flatness of surface in the antæ is contrasted with rotundity in the columns, vertical lines are opposed to inclined ones, and uniformity in regard to light stands in comparison to the varied play of light and shade on the shafts of the columns.

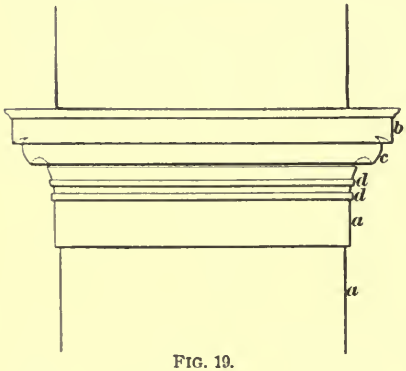


FIG. 19.

Instead of attempting to keep up a similarity between the shafts of the pilasters and the columns, the Greeks made a

studied distinction between antæ and columns, not only as noted above, but carried still further, for they never fluted the faces of their antæ, whereas in modern practice both pilasters and columns are fluted, as will be explained hereafter.

45. The **Ionic order** is lighter and more delicate than the Doric, being expressive of grace and refinement rather than of grandeur and dignity. It was used by the Greeks in temples dedicated to deities representing the more earthly sentiments, such as the Temple of Victory, the Temple of Minerva Polias, etc.

Although the capital is the distinguishing characteristic, the character of every detail of the order differs entirely from the Doric. Besides having the addition of a base, the shaft is taller and of more slender proportions, and much less tapering. The example of the Ionic order shown in drawing plate entitled, Grecian Ionic, is taken from the porch of the Temple of Minerva Polias, and shows the order in the zenith of its perfection. The capital *D* is not only more complex, but also more irregular than the Doric capital, as it has two faces or fronts, parallel to the architrave above it, one of which is shown at *D*, and two narrower bolster sides beneath the architrave, of which one is shown in Fig. 3. This irregularity is considered by many a defect, which can be obviated only by turning the volutes diagonally, as in some Roman and modern examples, or by curving concavely the faces of the capital, instead of making them planes, thereby obtaining four equal faces, as is done in the capitals of the inner order of the Temple of Apollo, at Bassæ, Fig. 20. However, the Ionic capital, as used in the Erechtheum (see Figs. 22 to 26, *History of Architecture*), and in the Temple of Nike Apteros, or Wingless Victory (Fig. 27, *History of Architecture*), on the Acropolis, at Athens, suits its position as well, and is as perfect an architectural feature as is the Doric order in the Parthenon.

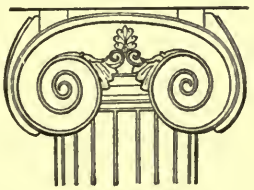


FIG. 20.

The only objection to the Ionic capital is that in the end columns of a portico it exhibits an offensive irregularity, because on the return side of the building the bolster shows itself beneath the face of the architrave; yet, even this is of no great consequence, unless the colonnade is continued down the sides of the building, and the capitals at the extremities present their bolster sides to the observer, while the intermediate ones show the voluted face. The Greeks, with their usual inventive ingenuity, gave the capital at the angle two adjoining voluted faces, so that it should agree with the other columns both on the front and on the flank of the building. This was accomplished by placing the volute at the angle diagonally, so as to obtain there two voluted surfaces placed immediately back to back, as shown in Fig. 21, which is an angle capital from an Ionic temple on the Ilissus River, near Athens. At *a* is the angle where the volutes are turned back to back, shown at *b* in the plan (*b*), and in Fig. 22 is shown a view of these two volutes as they would appear looking directly at the corner. We, therefore, have two volutes and two bolsters, as in any Ionic capital; but the volutes are on two adjacent sides *c*, *d*, Fig. 21, while the bolsters are on the two opposite adjacent sides *c*, *f*. A voluted face was thus kept to the outside on both sides of a corner, and the columns could be continued entirely around the cella.

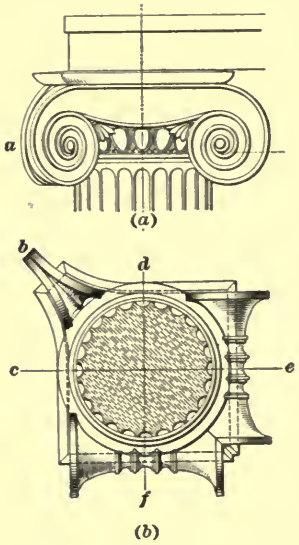


FIG. 21.

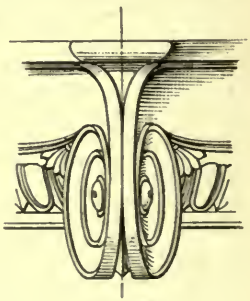


FIG. 22.

The Ionic order possesses a base which differs in outline and moldings according to the locality where the example

is found. The best examples existed in Attica, the state of which Athens was the capital, and the most artistic base, and the one best adapted to the order, is found here, and is known as the *Attic base*, shown at *A* in the drawing plate. It consists of two heavy torus moldings separated by a scotia and resting on a square plinth, or stylobate. The upper torus is sometimes carved with a guilloche ornament, as shown, or is left perfectly plain, as explained under the chapter on moldings.

46. The shaft *C* of the column is grooved by twenty-four flutes, each pair of flutes being separated by a fillet. These flutes extend from the apophyge, at the base of the shaft, to the astragal at the neck. The neck is enriched with a carved honeysuckle ornament, which is carried entirely around the column. Above the neck is a fillet and bead, and above this is a small echinus, which is carved with an egg-and-dart ornament. Resting upon this echinus is a small torus which separates the echinus from the *pulvinated*, or cushion-like, capital, the ends of which are terminated by the *volutes*. A number of bands are run across the face of the cushion and rolled up on each side. The abacus is a flat slab whose molded edge is carved with an egg-and-dart ornament.

The Ionic entablature, as expressed in terms of the diameter of the column, is greater than that of the Doric order; but in proportion to the length of the column, the Ionic entablature is less than the Doric. For example, the entablature of the Parthenon is about two diameters high, while the Ionic entablature is about two and one-third diameters high; but two and one-third diameters of a column nine diameters high equal about one-quarter the height of the column, while two diameters of a column only five and one-half diameters high equal about one-third the height of the column, thereby making the Ionic order lighter and more delicate than its dignified brother, the Doric.

47. The Ionic architrave does not differ materially from that of the Doric. Its average height is equal to the upper

diameter of the column, and it is usually divided into three surfaces, or courses, called *facias*, which very slightly project one over the other. There are a few examples where the architrave is left plain as in the Doric order, and in such cases the moldings are not so heavy as in this example from the Erechtheum. The Ionic frieze, being devoid of triglyphs and having no other characteristic member substituted for them, becomes a mere plain surface, interposed between the architrave and the cornice. This plainness may be relieved by carving thereon figures in bas-relief; but as sculpture of that kind does not belong to the character of the entablature, it is never taken into account in describing the details of the order. The Ionic cornice is a simple affair, especially in the Athenian examples, being merely a corona, with a cyma recta above it, and some narrow bed moldings beneath it. The soffit of the corona is hollowed out as shown by the dotted line, and the bed moldings above referred to are left when this soffit is so cut, and are here shown dotted under the corona. Between the corona and the cyma are two small enriched moldings, a bead, and another echinus.

This description completes the Grecian-Ionic order as seen on its voluted face; but as the order is not symmetrical on its four sides, further consideration must be given to its side views.

48. In Figs. 2, 3, 4, and 5, are given additional views of the capital and its details. Fig. 2 is a half plan of the under side looking upwards, and Fig. 3 is an elevation of the right-hand side. Figs. 4 and 5 are sections through the capital on the center axial lines shown at *a b* and *i j* of Fig. 2, the under side, or soffit, of the corona and cymatium, and Fig. 6 is a plan of the base *B*.

Returning to the composition of the front elevation of the capital *D*, we will first consider the neck of the shaft, and the fillet, echinus, and torus as being carried around the shaft in the same manner as the large echinus is carried around the Doric shaft. These three moldings are shown carried around the shaft in the plan as shown on the drawing

plate at Fig. 2, and two of them are seen in the side elevation Fig. 3, and their profile in the section Fig. 4 is seen under the bolster.

If we now consider the volutes as being composed of a number of narrow bands laid loosely across the edge of the torus, and then rolled up where they project over the edge, we have a fair idea of their composition. In the plan Fig. 2, and the side elevation Fig. 3, the edges of these bands are shown with the bolster or roll between them. These two bolsters, one on each side of the capital, are grooved with seven flutes separated by fillets and beads, which are similar to the flutes in the shaft of the column, except that those in the column are semicircular in section, while those in the bolster are semielliptical.

In the section shown in Fig. 5, we have the profile of the moldings of the capital and the bands of the spiral as they would appear if cut through on the axial line *a b* of Fig. 1.

In the section shown at Fig. 4, we see the solid portion of the bolster as it would appear if cut through on the axial line *a b* of Fig. 3, and the fillets and beads carried around the bolster as shown, Fig. 2.

49. The **Grecian-Corinthian** order is the lightest and most delicate of the three, but it is almost impossible to determine for what class of buildings the Greeks considered it best adapted, as there is but one perfect example left for us to judge by at the present day, and that is the choragic monument of Lysicrates, at Athens, shown in Fig. 23. Like the Ionic, the principal characteristic of the Corinthian order is its capital—tall, bell shaped, and richly foliated, as shown at *C* in the drawing plate entitled, Grecian Corinthian. As was said with regard to the entablature of the Ionic order, the capital of the Corinthian column is higher in proportion to the diameter of the column than is either the Ionic or the Doric; but, as the shaft is longer and slenderer than either of the others, it is able to carry a higher capital.

50. The Corinthian capital has two rows of leaves, eight in the upper row, and sixteen in the lower row, so disposed that,

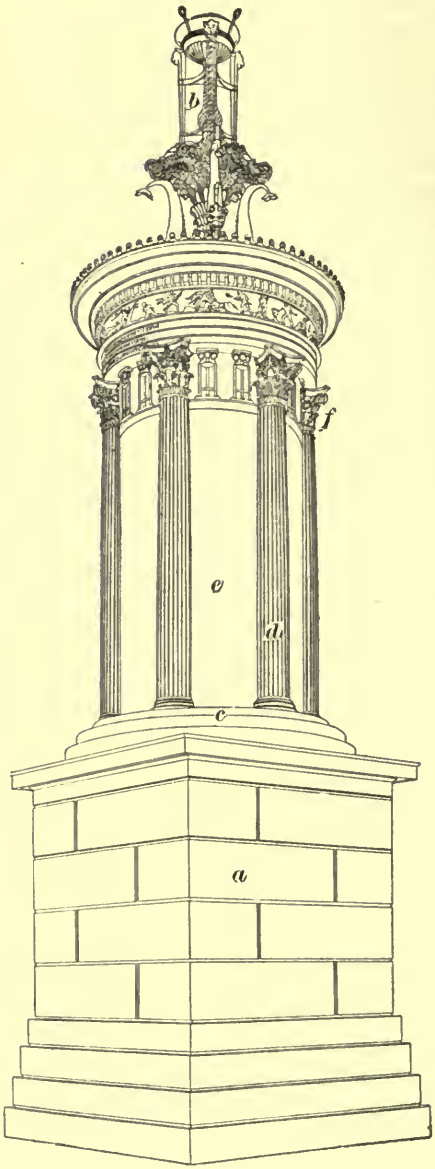


FIG. 23.

of the taller ones composing the upper row, one comes in the center beneath each face of the abacus, and the lower leaves alternate with the upper ones, coming both between and under the stems of the latter, so that in the first, or lower, tier of leaves there is, in the middle of each face, a leaf between each two leaves of the upper row, and also a leaf under the stem of the central leaf above them. Above these two rows is a third series of eight leaves, turned so as to support the small volutes, which in turn support the angles of the abacus. Besides these outer volutes, which are invariably turned diagonally, as in the four-faced Ionic capital, there are on each face of the capital two other smaller ones, termed *cauliculi*, which meet each other beneath a flower on the face of the abacus.

The abacus itself is different in shape from that of either of the other two orders. In the Doric it is, as we have seen, merely a thick slab resting on the echinus beneath it, and left absolutely plain; in the Ionic, also, it is square, but the sides are molded and sometimes carved, while the Corinthian abacus is, strictly speaking, not even square, except in general form. True, it has four equal sides, but instead of being straight, they are deeply concave in plan, and the acute point which would be formed by the meeting of these concave sides is usually cut off straight, thus making the abacus an eight-sided figure, four of whose sides are short and straight, while the other four are long and curved, as shown in Fig. 2. Thus, we see that the abacus here assumes a very different shape from its original one, yet merely to know this is to know very little; this form of it is, of course, a distinction, but it was not for the sake of distinction that it was adopted. It grew out of intention and purpose; it was dictated by necessity—or at least by artistic necessity, which insists that the abacus should be adjusted to conform to the upper part of the capital. Now, a square abacus would not suit a capital whose foliage spreads out so widely at the angles; so the Greeks curved the abacus to fit the capital, and overcame this difficulty as they had already overcome hundreds of others. This may to the student seem a very simple thing to do, and hardly worth his notice, but take into consideration the fact that these Greek artists had no rule or precept to follow, as we have today, that they had no authority to turn to and ask, "Is this right or wrong?" but had to rely upon their own judgment as to what best satisfied the eye from an esthetic point of view. The curvature of the cornice, the entasis of the column, the angular volute in the Ionic order, are all simple things in themselves; but as they appear suddenly in the history of architecture, without any similar form preceding or leading up to them, we must look upon them as inventions in art as important as they are apparently simple.

51. The base of the Grecian-Corinthian column *A* is of the Attic type, almost the same as that of the Ionic order;

and the shaft *B*, like the Ionic also, has twenty-four flutes separated by fillets, but these flutes and fillets terminate at the top very differently from the way they do in the Ionic. Here we have a row of leaf-like ends curling out from the column, with the fillets forming their central ribs. The edges of these leaves intersect in an angle, and this angle gradually flattens out until it disappears entirely in the surface of the flute. Above these leaf-like ends, and below the lower row of leaves in the capital, is a groove, cut entirely around the column, to emphasize the starting point of the capital, and which is said to have originally served as a receptacle for a braided band of bronze laurel leaves contrasting beautifully with the white marble of the monument.

The entablature is very similar to that of the Ionic order, with the exception of the cornice, which is larger and somewhat richer than the upper member in the order from the Erechtheum. The architrave is divided into three facias as in the previous order, but their surfaces are not perpendicular. On the contrary, the faces are battered back so that the three arrises, or edges, are perpendicular over one another, and the offsets are formed by the batter. The molding at the top of the architrave is a simple cyma reversa resting on a bead and surmounted by a rather heavy fillet. The *frieze* is shown here with the carved figures in relief as it appears in the original monument, although, as said before, this carving does not form a component part of the order itself. Above this frieze is a small *torus* and an ovolo supporting the dentil course. These dentils are small rectangular blocks, spaced about two-thirds their width apart, and in all probability are the stone representations of projecting ceiling joists, which existed in an early system of wooden construction. Dentils are also sometimes found in the Greek-Ionic entablature, but only in Asia Minor and other colonies, as the only example of a denticular cornice in an Attic-Ionic structure is that over the caryatid porch of the Erechtheum. This can scarcely be considered a satisfactory example, however, as the entire treatment of plan, elevation, and arrangement of the Erechtheum is entirely different

from any other building in Attica; and, differing so materially in other points, it is not strange to find a dentil course over the caryatid porch, which is itself unique and might be considered a separate order.

Above this dentil course is a cyma recta, supporting a cyma-reversa bed molding under the corona. This corona projects more in the Corinthian than does the same member in the Ionic order; and the crowning member, instead of being a cyma as in the previous order, consists of a series of *antefixæ* supported upon a serrated band which is separated from the corona by a small echinus. In Fig. 6 is shown the under side of the entablature, taken on a line through the frieze *E*. In Figs. 2 and 3 are shown a plan of the under side, and a corner elevation, of the capital *C*. In Fig. 5 is a plan of the base *A* taken on a section line through the column, so as to show the depth of the flutings and the width of the fillets.

This completes the general description of the Grecian orders, a description that has been here given somewhat in detail, in order that the student may fully comprehend the liberties that were taken with these orders when the Romans converted them to their own uses.

52. The Five Orders of Architecture according to Vignola will now be analyzed and described, and the attention of the student is called particularly to the unrefining influence of the Romans as expressed in their interpretation of the Greek art forms.

In *History of Architecture* will be found the statement, "The Romans were not an imaginative race, and had few original ideas in architecture. Their early works were copied from the Etruscans, and their latter efforts were borrowed from the Greeks." In nothing is this fact more evident than in the first of the five Roman orders, namely, the Tuscan.

53. The Tuscan order is but a modified form of the Grecian Doric, or, perhaps, more strictly speaking, it is an

undeveloped form of the Roman Doric. It takes its name from the Etruscan people, who are supposed to be its originators, though it is not improbable that the Etruscans received their ideas from the same source as did the Dorians, both nations having emigrated from Asia, within two hundred years of each other. One thing is certainly true, the Tuscan column and entablature bear a closer resemblance to the proportions of the Greek Doric than they do to the Roman Doric, which was admitted to be more or less copied from it; and the Roman Doric resembles more the Tuscan column and entablature than it does the Grecian order, whose name it bears. Hence, we see that the Tuscan is a sort of connecting link between the Greek and the Roman orders. It contains many Greek details which the Roman Doric does not, while, on the other hand, the Roman Doric possesses many Tuscan features unheard of in the Greek. The characteristics of the order are its crudeness and plainness combined with its heavy moldings and lack of refinement in outline. It has, like all other Roman orders, a regularly proportioned and molded pedestal, which, though not a specific part of the order itself, is generally drawn with it when the order is shown alone.

54. In drawing plate entitled, Tuscan Order, the details are drawn out complete, with the exception of the shaft of the column, a portion of which is outlined in half elevation in Fig. 5. The pedestal is simply a square block *B*, with an apophyge, or escape to the fillet, resting on the plinth *A* at the bottom, and with a cyma reversa and a fillet at the top. Upon this stands the base of the column *D*, which consists of a torus and a fillet resting upon a square plinth. The capital *F* is in some respects similar to the Doric, but lacks both the refinement of the Grecian Doric and the delicacy of the Roman. It consists of an abacus, ovolo, and necking. The abacus is square in plan, and is composed of a fillet resting upon a plain facia which has an apophyge, or curved escape to the fillet. The ovolo is a plain molding often referred to as a quarter round, as its

section is exactly a quarter of a circle. This ovolo of the column is circular in plan, as shown in Fig. 3—which is a plan of the under side of the column taken on the line *e f* —the ovolo and the fillet beneath it are simply a quarter round and a square offset, bent or worked around the neck of the column.

The entablature is subdivided into an architrave *G*, a frieze *H*, and a cornice *I*, in proportions nearer to the Grecian Doric than is the Roman order of that name. But the triglyphs and mutules characteristic of the Doric order are omitted entirely, while the moldings are large and heavy and out of proportion to the surfaces they are intended to ornament. The shaft of the Tuscan column is never fluted, and no carving or enrichment of its moldings or surfaces is ever practised. It has never been popular with modern architects, and the only example of any importance in modern work is the little church of St. Paul's, Covent Garden, London, by Inigo Jones. It was probably used here because it was cheap, and though the design is full of strength and character, it certainly shows the unfitness of the Tuscan order for such a portico.

In Fig. 4 is shown a plan taken on the line *c d* of the base of the column and the top of the pedestal. The projecting corners of the square plinth are shown beyond the curve of the torus, and the solid part of the shaft is shown by the sectioned portion. In Fig. 2 is shown a plan of the under side of the entablature, looking upwards. The sectioned portion shows the lower bed of the frieze on the line *v w*, on which line the section or plan is taken. The lines *a''' b'''* and *g'' h''* show the relative positions of the center lines of the columns, their intersection being on the axis of the corner column around which the entablature returns; the moldings of the entablature miter on the line *x z*. In Fig. 5 is shown a half elevation of the curved portion of the shaft of the column and the method of profiling its entasis.

55. Before making a comparison of the Greek and Roman orders, let us first consider some of the conditions

that made alteration necessary before the art creations of the Greeks could be adopted by the Roman builders.

In *History of Architecture* we read that "the distinguishing characteristic of all Roman architecture is the persistent use of the arch." The Greeks spanned their openings with lintels—simple stone beams laid across from one column to another—and the width of the openings they could thus span was limited by the length of the stones they could conveniently quarry. But, by means of the arch, the Romans could span any width desirable; but the pressure of the arch at the abutments was in the character of a horizontal thrust, which would overthrow any ordinary column, and especially such columns as were used by the Greeks, laid up in several courses and devoid of mortar or cement.

Heavy masonry piers, laid up in strong mortar with securely bonded courses, became necessary, therefore, to withstand this thrust, and the Romans, having no structural use for the Greek orders, applied them as ornament to their masonry abutments.

The orders, thus backed up by heavy piers, did not require that appearance of sturdy independence which the Greeks instilled into their supports, and were consequently drawn out longer and thinner, and embellished by much carving and enrichment, as though endeavoring to attract the attention to their false beauty, while the piers and arches did the real mechanical work of holding up the building.

This will, perhaps, be more clearly understood by referring to Fig. 28, which is a portion of the facade of the Colosseum, at Rome. The arches *v* resting upon the piers *x*, *y*, and *z* support all the mason work above them, while the columns *e*, *f*, and *g*, and the entablatures *h*, *i*, and *j* are applied to the structure simply as ornament. Strip these columns off, and the building will stand as well as with them, but in appearance it will be simply a structural edifice entirely utilitarian, and in no way esthetic.

Greek designers made their architecture beautiful by ornamenting the construction itself—remove the column, entablature, or the pediment, and you remove the essentials

of the structure—but the Romans designed the structure entirely apart from the ornament, and the latter might easily be removed without injury to the strength of the fabric.

56. The Doric column, as used by the Greeks, was but five or seven diameters in length, and the bottom of the shaft being of the greatest diameter, it required no base to stand on, and was beautiful in its simplicity. The Doric of the Romans, as shown in drawing plate entitled, Doric Order, was, on the contrary, eight or more diameters in height, and the bottom of its shaft was so small, in proportion, that a regular molded base became necessary to give it an appearance of stability. There are instances where the column was used without a base, and the first story of the Theater of Marcellus, at Rome (a detail of which is shown in *History of Architecture*, Fig. 30), is a most excellent example of the struggle to apply the Tuscan details to the Greek form. The lower order of the Theater of Marcellus presents the Tuscan entablature with triglyphs in the frieze and guttæ under the tænia, while the mutules are omitted entirely, and a row of dentils and bed moldings is inserted under the soffit of the corona. The column is not fluted and stands upon the stylobate or plinth without a base, while the capital is molded after the Tuscan model. As a result, this, as an example of the Doric order, is as characterless an ordinance as can anywhere be found, and the alterations of its details brought it finally to the form shown in the above mentioned drawing plate, which is the standard proportion according to Vignola, and, with slight modifications, is the form and detail in which we find the order used in modern work down to the present day.

57. The pedestal is higher in proportion to its width than the Tuscan, and its base exhibits more moldings than does the latter. The addition of a subplinth serves to raise the die *B* above the ground line without producing too broad a band under the base. The importance of these items will exhibit themselves when we refer to the use of the orders in

interior decoration. The cornice moldings of the pedestal are much like the members of the Tuscan entablature, and show another point of resemblance between these two orders. The base *D* of the column is almost identical with that of the Tuscan order, with the slight addition of a bead molding between the torus and the fillet. The column is fluted with shallow grooves which meet in an arris as in the Greek order, but, unlike the latter, they die out or terminate below the line *c d* which marks the apophyge of the shaft at the base. The capital *F* of the column is decidedly more Tuscan than Greek. It is separated from the shaft by a projecting fillet and bead which in this position is called an *astragal.* Instead of the annulets beneath the echinus as in the Greek capital, we have simply three projecting fillets, and the echinus is rounded out until it becomes in section a mere quarter circle. The abacus is square, but has a crowning member, and it has panels sunk in the corners of its soffit, as shown by the dotted lines at *s.* Fig. 3 is a plan of the under side of the capital and abacus taken on the line *e f* of Fig. 1, showing the under side of the ovolo and the panels sunk in the abacus. The proportions of the entablature are entirely different from the Greek order, and in some examples would scarcely be recognized as Doric at all.

58. There are, in fact, two distinct systems of grouping the members of the Roman-Doric entablature: one, as in the Greek, with mutules in the frieze, and the other—an entirely Roman invention—with a course of dentils under the corona.

The mutular Doric is the order shown in the drawing plate; and, as will be at once observed, its entablature bears but a slight resemblance to the Grecian model. The architrave *G* is divided into two facias, the upper one projecting slightly over the lower one somewhat in the manner of the Greek Ionic. The triglyphs of the frieze *H* are always centered over the axes of the columns, and consequently the metopes, which were always square in the Greek order, are often an oblong in the Roman, with the longer axis set either vertically or horizontally.

The mutules, which in the cornice of the Parthenon were set over each triglyph and metope, existed over the triglyphs only in the Roman-Doric structures, and the soffit of the corona between them was paneled in lozenge or rectangular forms, as shown by the dotted lines. A plan of the soffit of the Roman-Doric entablature taken on a line through the frieze is shown in Fig. 2, where *J*, *K*, *L*, *M*, and *N* are the various shaped panels between the mutules; the line *x z* denotes the miter of the return. At $a'''\ b'''$ and $g''\ h''$ are the lines on which the centers of the columns are spaced, and their intersection defines the axis of the corner column.

The cornice *I*, Fig. 1, is lighter and more delicate than in the Tuscan order, and its epitithedas is a cyma recta instead of an echinus.

In Fig. 4 is shown a plan of the base on the line *c d*, while $a''\ b''$ and *g h* are its axial lines. The half elevation of the curved outline of the shaft is shown in Fig. 5, and is lettered as in the previous order, and its entasis is drawn in the same manner.

59. The result of the Romanizing of the Ionic order is shown in the drawing plate entitled, Ionic Order, and is scarcely more successful than the Doric. The Romans never seemed to understand the possibilities of the order from the Erechtheum, and as a consequence only three accredited examples of the Roman-Ionic column are known today. These are the Temple of Fortuna Virilis, the Temple of Concord, and the second story of the Theater Marcellus. The first of these is by far the best, its volutes retaining much of the Greek character, while the last is the simplest and plainest, and also the smallest in its proportions; but the second is remarkable for its ugliness in general, and the inartistic arrangement of its volutes in particular, which spring out diagonally so as to present four equal and similar faces.

The example shown on drawing plate entitled, Ionic Order, is taken principally from the first of those above mentioned, with only such alterations as are necessary to

bring it down to a general type. In it we find the pedestal slightly longer in the die than was the Doric, while the cornice *C* and base *B* of the pedestal are more richly molded than in either of the previous orders. The base *D* of the column, however, is of the familiar Attic type which has already been described in connection with the Greek-Ionic order, and exhibits the first point of strong resemblance to the Grecian ancestor. The shaft of the column is nearly of the same height as the Greek; and in many examples is grooved by twenty-four flutes separated by fillets, though in this example there are but twenty.

By a strange perversity, however, when we arrive at the capital we meet a striking difference from the Athenian order. In the columns of the portico of the Erechtheum we have a *necking*, between the echinus of the capital and the astragal of the column; but in the Roman Ionic the flutes of the shaft extend almost to the eyes of the volutes. In their Doric order the Romans inserted a necking above, which did not exist in the Greek order and must have been borrowed from the Attic Ionic, or possibly from the Tuscan; but when they adopted the Ionic order they seem to have taken especial pains to omit the detail which, according to previous appearances, they particularly admired. For some reason, they omitted this necking, and the Roman-Ionic capital has a flat, crushed appearance in consequence, as shown. In carving the volutes of the capital, they simplified the Greek spiral greatly, not necessarily from choice, but probably from necessity. The Roman designer was a mathematician, but not an artist; he was a clever engineer, but hardly an architect; and consequently he tried to reduce the Greek spiral to a simple geometrical rule, and in the same manner as he struck the curves of his moldings—with a compass—he produced the volute for his capital with tangent arcs of different circles. The method used by the Grecian architects in executing the spirals of the Ionic columns, remains to this day more or less a matter of conjecture. No method had been discovered to reproduce them exactly during the age of Roman art, and today we have to rely upon the results of

modern investigation to reproduce them with any degree of accuracy. The Roman-Ionic volute contains but one band, while that of the Greeks possessed three, though there are instances where a single band was coiled in the capital of the Greek order, as in the temple on the Ilissus River, Fig. 21. But the Ionic order reached the zenith of its perfection in the Erechtheum, and it is with the details of that building we must compare any subsequent Ionic constructions.

The architrave *G* and frieze *H* of the Roman order are very similar to those of the Greek, but between the frieze *H* and corona of *I* is inserted a row of dentils with upper and lower bed moldings, which cast a serrated shadow and emphasize the projection of the corona.

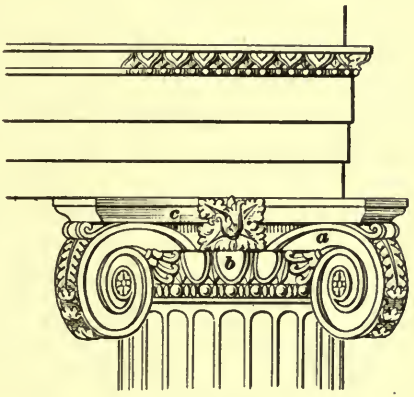


Fig. 24.

60. The Ionic capital above referred to in the Temple of Concord is illustrated in Fig. 24. It is shown here not on account of its architectural beauty, for it has none, but because in certain classes of early Renaissance work this style of cap was redesigned by Palladio and used in combinations where its defects were not so glaring. The principle upon which this cap is designed is that the volutes *a* are growing out, and curling over the edge of the contracted echinus *b*, while the whole is covered with an eight-sided abacus *c*, strongly resembling the Corinthian. The space under the abacus and between the volutes is filled with a carved rosette, or in a few instances with an animal's head. More will be learned about this particular form of Ionic capital when we take up the subject of Renaissance design.

In Fig. 4 of the drawing plate is shown a plan of the base

of the column, as well as the top of the pedestal. This plan is taken looking down on the column cut through on the section line *c d*, and the lines *a" b"* and *g h* are axial lines through the center of the base.

Fig. 3 shows a plan of the under side of the capital, looking upwards; it shows the bolsters on the side of the column and the projecting echinus on the front and back.

In Fig. 6 is shown an enlarged diagram of the volute and and the adjacent members composing the necking of the column; this diagram is just four times as large as the volute, shown in the main elevation of the capital, and is drawn to a proportional scale.

61. The curves of the spiral of the volute are drawn as follows: At right angles to the line *i j* draw the line *k l*, and draw a line through *k k* at a distance of 15 parts above the line *i j*; the diameter of the *eye* of the volute, being $\frac{1}{4}$ of this distance, will be $3\frac{3}{4}$ parts. From the point of intersection of the center line *i j*, and the line *k l*, with a radius equal to $1\frac{7}{8}$ parts, describe the circle representing the eye; as the spiral line is composed of simple arcs, each being $\frac{1}{4}$ the circumference of a circle, it will be necessary to establish a series of centers from which the arcs may be described, and as the volute makes 3 complete involutions, 12 centers will be required. The method of establishing these centers is more clearly shown in Fig. 7, where a circle is described on the axial lines *a b* and *c d*, with a diameter 3 times the diameter of the eye shown in Fig. 6; the lines *a c*, *a d*, *b c*, and *b d* are then drawn, and the lines *a c* and *a d* are bisected in points *2* and *1*, respectively, and radial lines are drawn from these points to the center of the circle. The line *2–12* is then divided into three equal parts, giving the points *6* and *10*. Through points *2*, *6*, and *10*, lines parallel to *c d* are drawn, and the vertical distance between the line *2–1* and *c d* is thus also divided into three equal spaces. Now the line *3–4* is drawn, at a distance from *c d* equal to $2\frac{1}{2}$ of these spaces; from points *2* and *5*, vertical lines defining the points *3* and *4* are drawn, and from the latter points diagonal lines

at an angle of 45° are drawn intersecting on line *c d*; verticals from *6* to *7*, *10* to *11*, and *9* to *8*, and horizontals from *7* to *8* and *11* to *12* complete the figure; the centers for drawing the arcs are *1*, *2*, *3*, *4*, etc., and are used in the order in which they occur. Locate these centers in the eye of Fig. 6 by the method followed in Fig. 7, and proceed to draw the arcs. From the center *1*, with a radius equal to $1\text{–}1_1$, draw the arc $1_1\text{–}2_1$; from center *2*, with a radius equal to $2\text{–}2_1$, draw the arc $2_1\text{–}3_1$, and continue thus until the outer line of the volute is complete. The method of drawing the inner line of the volute will be found in *Advanced Architectural Drawing*. The reversed dotted curve *k n o* shows the curvature of the strap of the bolster on the center line *g′ h′* of Fig. 3.

In Fig. 2 is shown a plan of the soffit of the corona, looking upwards from the line *v w* of Fig. 1; *a‴ b‴* and *g″ h″* are the axial lines on which the columns are spaced. The method of profiling the entasis is shown in Fig. 5, and is similar to the previous cases.

62. We now come to the Corinthian, which we may consider a typical Roman order. There is but one example of richly foliated capitals in all Grecian art, and the modern Corinthian order, though probably taken from it, bears but a general resemblance to its prototype. We have gone into the details of the Grecian-Corinthian capital, and the Roman style will only be dwelt upon where it contrasts with the details of the Greek. The Roman-Corinthian capital, shown at *F* in drawing plate entitled, Corinthian Order, has two rows of leaves, eight in each row, so disposed that of the taller ones composing the upper row, one comes in the middle beneath

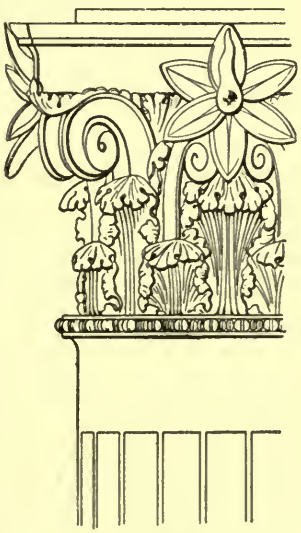


FIG. 25.

each face of the abacus, and the lower leaves alternate with the upper ones, coming between the stems of the latter; so that in the first or lower tier of leaves there is in the middle of each face a space between two leaves occupied by the stem of the central leaf above them. By comparing this with the Greek order we find the principal difference between them lies not so much in the leaves themselves as in their number and arrangement; the capital from the monument of Lysicrates being a simple and refined arrangement of leaves and tendrils, while in the capitals from the Temples of Vesta, Fig. 25, and Jupiter Stator, Fig. 26, the foliage is more luxuriant than refined. However, it is a characteristic of all Roman architecture that luxury should exceed refinement, and we will see this in every detail of the two last of the Roman orders.

FIG. 26.

63. In drawing plate entitled, Corinthian Order, the example is not taken from any particular edifice, but is compiled from a number of different structures, in order to get a general type of the order. The shaft here is fluted with twenty-four flutes, though in many of the best examples it is not fluted at all. The portico of the Pantheon possesses one of the handsomest examples of the Corinthian order in Rome, but the granite columns are left unfluted, and their surfaces are highly polished to compensate for the omission (see Fig. 33. *History of Architecture*). The base of the Corinthian column varies somewhat in different examples, but is most frequently an enriched variation of the Grecian Attic. It is scarcely necessary to comment on the pedestal of either the Corinthian or Composite orders, as there is no change from the pedestal of the previously described orders, except an elongation of the die and an increase of the number of the

moldings which ornament its top *C* and base *A*. The same may be said of the base *D* of the column, the only change from the previous orders being an increase of the members between the two torus moldings. The shaft *E* of the column is but slightly longer than in the Ionic order, but the increase in the height of the capital makes the entire column ten diameters high. The entablature, however, is very different from any we have yet described. The architrave *G* is divided into three horizontal bands, or facias, as was the Ionic, but instead of a plain projection of one facia beyond the other, they are separated by a number of different small moldings, which, in nearly every instance, were carved and enriched almost to excess. The frieze *H* is here shown as plain, but the majority of examples show it carved in high relief. The cornice *I* exhibits the greatest alteration from the previous orders that we have yet seen. A row of dentils are supported by a cyma reversa immediately above the frieze, similar to the Ionic arrangement; but immediately above this we have a heavy ovolo supporting a row or course of *modillions*.

64. A **modillion** is the projecting bracket supporting the corona of the Corinthian entablature, as shown in Figs. 7 and 8 of the above drawing plate. These brackets possess a volute somewhat similar to that of the Ionic capital, but curved in the opposite direction.

65. The entasis of the column is profiled as in Fig. 5, where the reference letters are the same as in the previous plate. Above the modillions in the entablature are the corona and cyma recta, as in the Ionic. All these moldings are usually richly ornamented, and the entire order is usually decorated as lavishly as unrefined taste and unlimited purse could combine to make it. The moldings of the abacus, the tori of the base, and even the flutes of the shaft were in many cases enriched beyond all idea of temperance and good taste.

The character of the ornament carved upon the moldings

is described in the chapter upon classic moldings, but the enrichment of the flutings was different. It was customary to carve the flutings as though a rope was laid in them from the apophyge at the bottom of the shaft, up one-third its height. These rope moldings or ornaments were sometimes plain, straight rods, but in most cases were carved as twisted rope, or braided, and the upper two-thirds of the column was of ordinary fluting or was left unfluted.

In Fig. 6 is shown a half plan of the under side of the capital on the line ij; Figs. 2 and 3 show a corner elevation and a plan of the under side of the bell, or body, of the capital, with the leaves a' and b' removed. At Fig. 4 is a plan of the base on the line cd of the elevation. In Figs. 2, 3, and 4, the vertical axial line $a''b''$ passes through the center of each detail as does ab in the elevation, and the line $g'h'$ marks the transverse axis of the plan of the base, while $g''h''$ is the axial line passing through the corners of the abacus. The concave sides of the abacus are formed with an arc of a circle, having its center at the apex of an equilateral triangle, whose base connects the intersections of the axial lines with the corners of the abacus.

In Fig. 9 is shown a plan of the under side of the cornice showing the mitering of the members on the line xz. The axial lines $a'''b'''$ and $g'''h'''$ both pass through the centers of modillions, as these details must always be spaced so as to center over the columns.

66. It is not the intention of the plates herewith given to furnish a pattern by which each order shall be constructed, but to establish a general proportion which will enable the student to lay out his columns and entablature and execute such enrichment as he may see fit or as circumstances may dictate. The dissimilar varieties belonging to the same order, which we find in ancient art, show plainly that the architects of antiquity considered themselves at liberty to design their own detail and to treat an order as a composition, marked out for them in its leading forms and general proportions, and in no instance do we find the liberties taken

so great as in the Corinthian order; the arrangement of the leaves, the size of the volutes, the molding of the abacus, vary in different examples until it is hard to decide whether some of them do not belong to a different order, and if we do classify some of them in an advanced order, the difficulty then presents itself as to where to draw the line.

Between the Corinthian and Composite orders there is very little difference except in the size of the volutes, and with the exception of the capital of the column there is scarcely any difference in the proportions of their parts. Drawing plate entitled, Composite Order, shows the general form of this essentially Roman composition, but omitting entirely the ornamentation of the frieze and moldings which is as much a part of this order as the triglyphs are of the Doric. Ornamentation as a rule forms no part of the order which it enriches, and consequently should not be considered a part of the structure of the order, but the Composite order was invented by the Romans for no other purpose than to carry heavy ornamentation; in fact, it was the excessive and extravagant ornamentation of the Corinthian order that caused the Composite to spring into existence, and our example is, therefore, not complete until it receives such ornamentation as may be appropriate to its purpose. The general form is here given and the application of ornament will be discussed later in its proper place.

The pedestal of the Composite order is almost identical with that of the Corinthian, there being but a few slight changes in the moldings of its base and its cap while the die is a trifle longer. The base, shaft, and capital of the column are the same height as the Corinthian, and with the exception of the capital are almost the same in design. The architrave, frieze, and cornice have the same relative proportions as in the previous order, but are treated somewhat more elaborately in the subdivisions of their parts.

The Composite capital is a combination of the Corinthian and the Ionic capital from the Roman Temple of Concord, heretofore referred to. It is not an artistic combination, but its broad, strong volutes give an unusual surface on which

to carve florid ornament, and as such it suited exactly the later-day admirers of everything strictly Roman. It suits its place in modern art very well, when in proper handling, but the Renaissance architects were conspicuous in Italy by the interior application of the Composite order in every spot where it did not belong.

The volutes of the Composite capital are described in the same manner as those of the Ionic order, the radius of the eye being one-eighth of the distance from the top of the volute to the center. The arcs of the volute are then described from the centers located as shown in Figs. 7 and 8, in the same manner as for the Ionic order.

Figs. 2 and 6 show plans of the under side of the capital on the line *ij*, and in Fig. 3 is a corner elevation of the capital, the left half showing the relative position of the leaves on the bell, while the right half shows the relation between the abacus and the bell, or body, of the capital. Fig. 9 is a plan of the soffit of the corona, and Fig. 5 is a half elevation of the entasis of the column. All reference letters on Figs. 2, 3, 4, 5, and 9 refer to the same parts as similar letters on the Corinthian plate.

67. Having considered each one of the five orders separately, and measured the proportions of each of its parts in terms of the semi-diameter, we will now compare the orders as a whole.

The fact that the Tuscan order is but seven diameters in height, while the Corinthian order is ten, is likely to leave the student with the impression that the latter is a taller or bigger order than the former. This, in point of fact, is not so, as no direct comparison can be made between two architectural features so widely different in their origin and application. A Tuscan column of the same diameter as a Corinthian would necessarily be much shorter, but in an architectural composition where one would be appropriate, the other would be entirely out of place, thereby rendering a comparison impossible. On the other hand, a Corinthian column of the same length as a Tuscan column would naturally have a

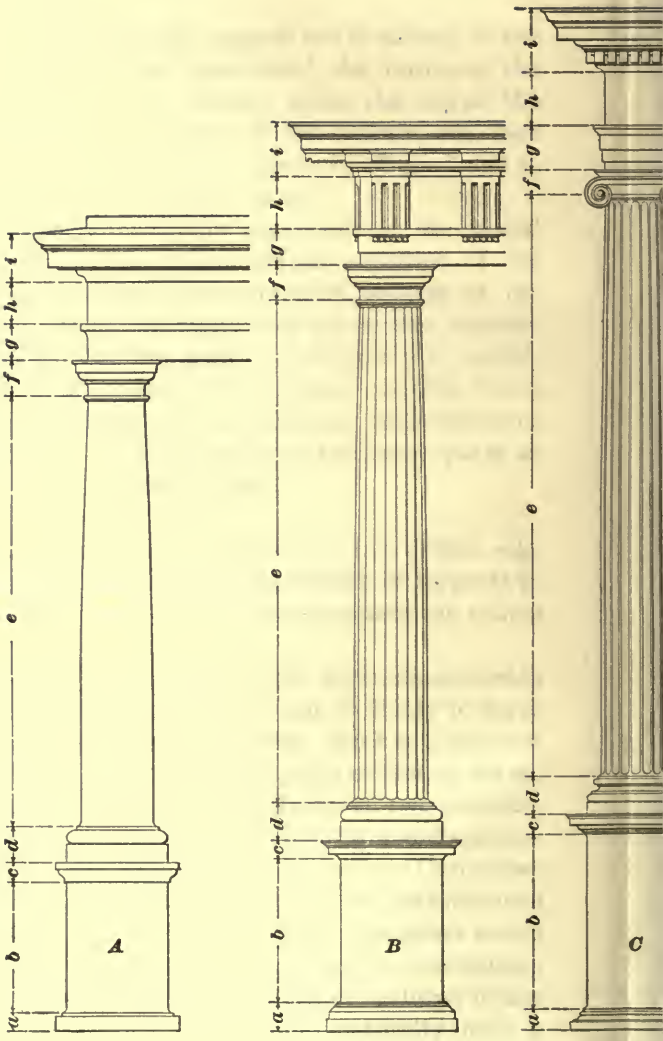
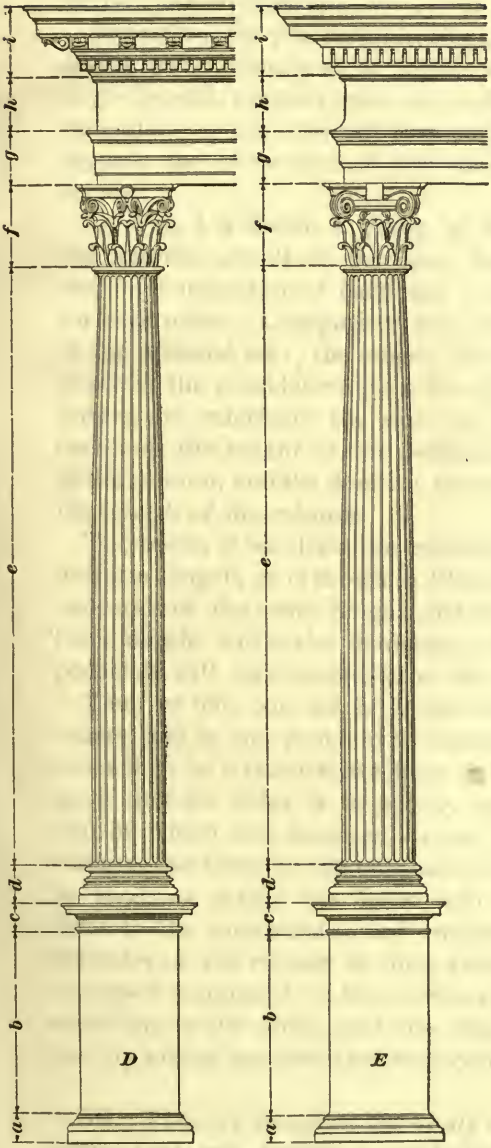


PLATE I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smaller diameter, but for similar reasons no direct comparison can be made.

Therefore, for practical purposes, we should consider each of the orders simply as a *system*, the magnitude of whose parts depends entirely upon the order itself, and this magnitude is in no way derived from any other source, except as regards the proportion of the whole to the space it has to occupy.

In Plate I is shown a group of the five orders, in which the columns are all of the same diameter, and the pedestal and the entablature of each are in the proportion required for each order. Comparison will now show that the height of the pedestal *a b c*, the length of the column *d c f*, and the depth of the entablature *g h i*, though different in each of the orders, are relatively the same in all of them; that is, in each case the height of the pedestal is one-third the length of the column, and the depth of the entablature is one-quarter the length of the column.

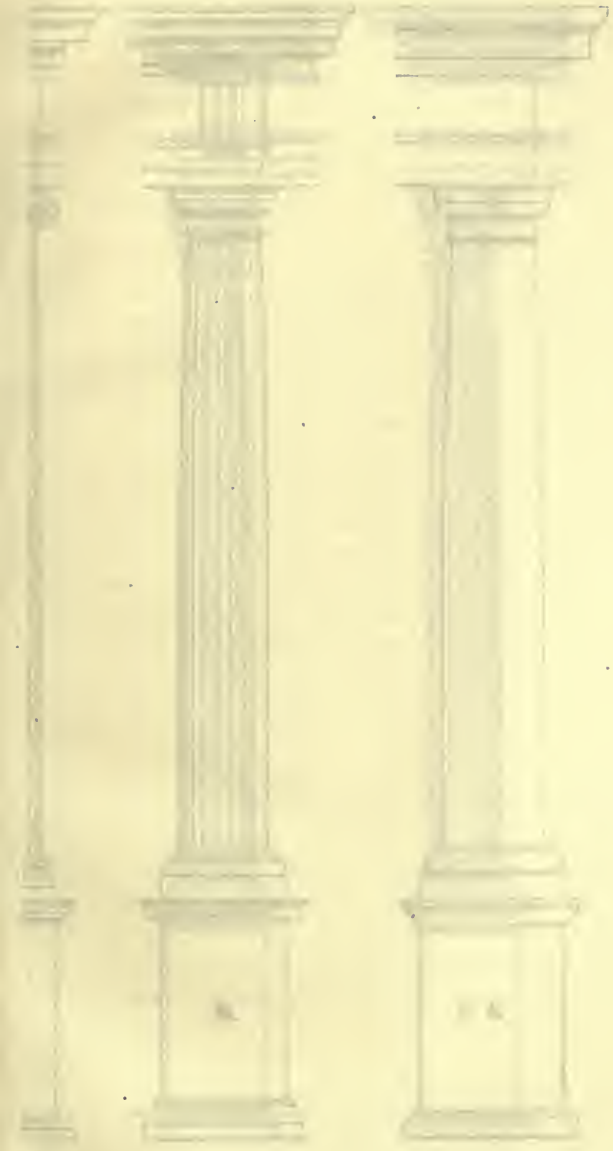
Therefore, if we draw the columns in the five orders to a uniform length, as is shown in Plate II, we shall have all the pedestals of the same height and the entablatures of a uniform depth, while the diameters of the columns and the pedestals will vary according to the order.

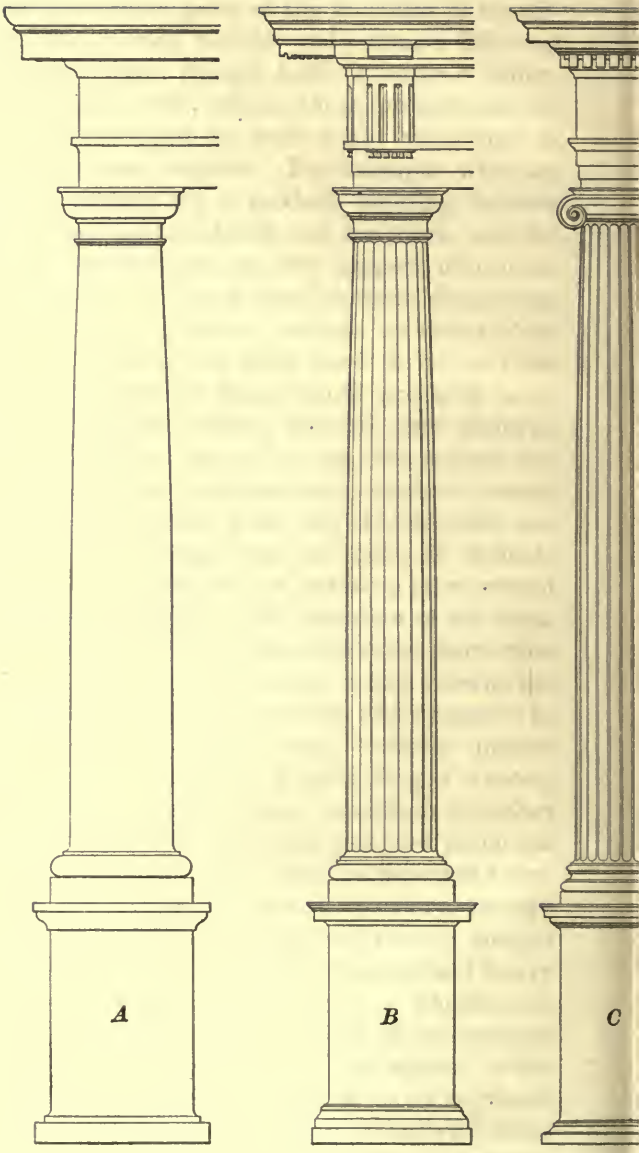
Thus we find one set of proportions common to all five orders, and in any problem in architectural design where an order is to be a feature, we have first to divide the vertical space that the order is to occupy into nineteen equal parts, four of which are assigned to the pedestal, twelve to the column, and three to the entablature; or, if no pedestal is to be used, we divide the space into fifteen parts, assigning three to the entablature and twelve to the column. The diameter of the column is then ascertained, by subdividing the space assigned to it into seven, eight, nine, or ten parts, according to the order, and the other proportions are filled out, by taking one-half the subdivision as the module.

68. Thus we complete the study of the only architectural forms that will permit a mathematical analysis of their

proportions. Every detail of the five orders of Architecture can be measured in terms or parts of the diameter of its column, and we are thus enabled to study and compare different examples of the same order, though built on entirely different scales. As has been said before, these proportions are not absolute and are subject to such slight variations as modern circumstances may require. For example, when an architect designs a column for a modern building, he uses the classic proportions only to block out his lines, and the material, situation, and purpose of the support determine the details of its design. A small wood column supporting an interior arch would be grooved perhaps by twenty-four flutes; whereas, if the same size shaft were to be cut from stone, twenty, or even sixteen, flutes would probably be as many as would be proper — simply because one material admits of finer working than the other, and the trained eye recognizes an overworked or underworked ornament immediately. An ornament carved in wood might look crude and unfinished, because the cutting was not deep or delicate enough, whereas the same amount of detail in stone would possibly be considered excessive. The situation of the ornament or column, as regards the eye, also affects the proportion of its parts. The modillions of a cornice which crowns the top of a high building are much more crude and excessive in their proportions than the simple and delicate plaster brackets which ornament the borders of the ceiling of a room; and finally the purpose of the column, modillion, or other detail will determine still more positively just how much the proportions given in the five orders shall be deviated from. If a column is supporting a heavy mass of masonry, the eye at a glance can tell that there are tons and tons of weight upon it, and the column must be crude and strong and heavy in its proportions, in order to satisfy the eye; whereas, on the other hand, if the column forms one side of an entrance and simply carries a light entablature, it will appear to the best advantage when the proportions of its parts approach most closely to the formal relations as given in the five orders.

The five orders are therefore given the student to practise





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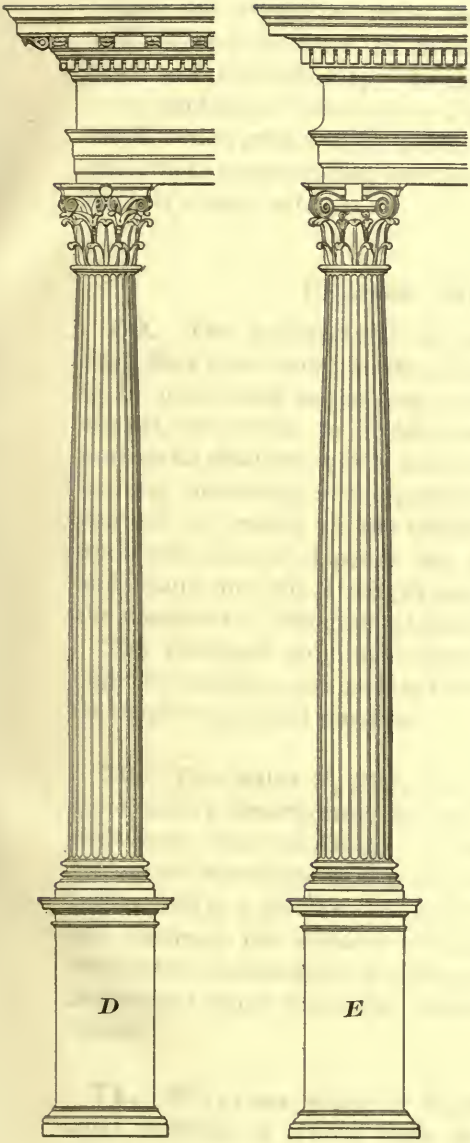
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by, in the same manner as a writing teacher gives a copy of letters and words, but when the student becomes proficient and discards his copy, he develops in his handwriting, character and individuality. In the same manner, the architectural student will develop in his designs personal characteristics, which give variety to the work and prevent the use of the orders degenerating into a mere copying of the forms of ancient classic art.

CLASSIC MOLDINGS.

69. The architectural purpose of moldings is twofold: first, they give variety to the outline of the principal divisions of an order, such as the base, capital, entablature, etc.; and second, they serve to divide the vertical surfaces and cast horizontal shadows which accentuate the divisions, thus preventing monotony in the general mass. In either case the contour, or profile, of the molding is of vast importance, as upon this contour depends the subtlety of the play of light and shade and the strength and depth of the shadows, and the character of the general outline.

The principal moldings found in classic architecture are eight in number, and each is known by the name describing its shape or general purpose.

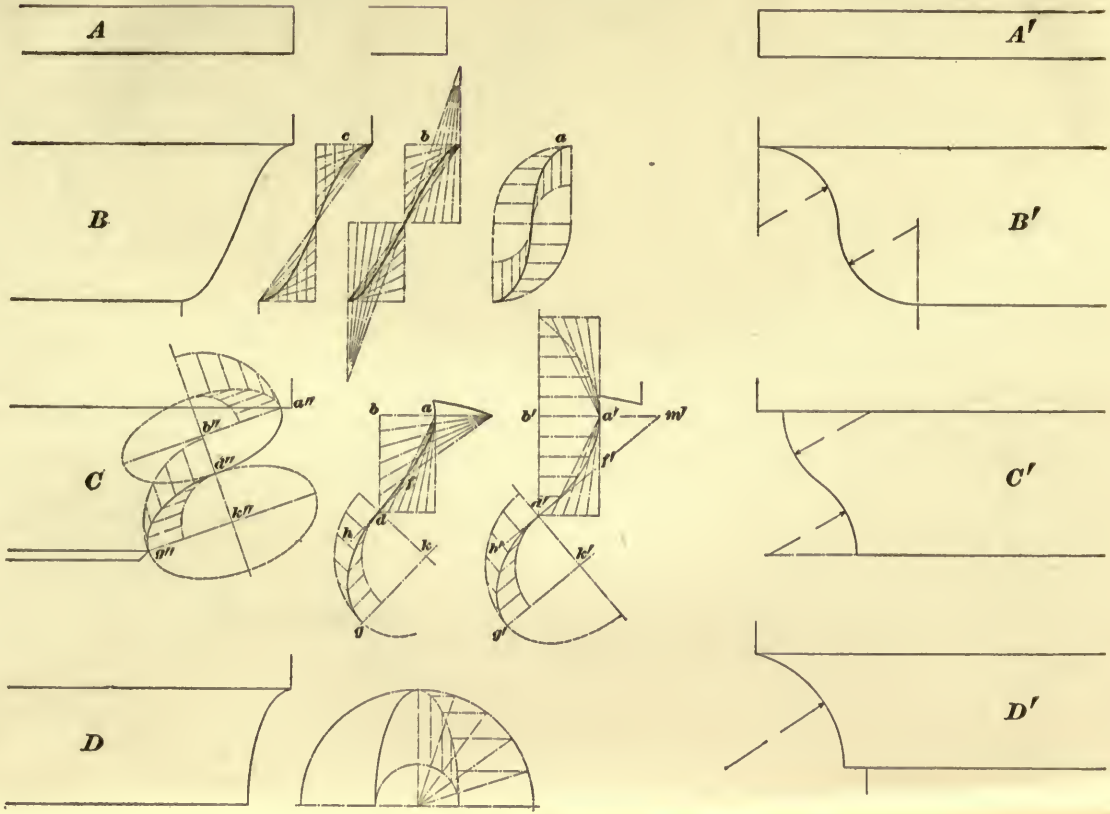
70. The **fillet** *A*, Plate III, is simply a square-edged band, rarely ornamented, and generally used in connection with some other molding. It is much used to separate the individual members of a group of moldings, as in the base and capital of a column, and also to emphasize the divisional line between the surfaces of distinct members, as in the entablature, between the architrave and the frieze. The *fillet* derives its name from the Latin word *filum*, meaning a thread.

71. The **cyma,** shown at *B* and *C*, Plate III, is an undulated molding, of which there are two forms, namely, the *cyma recta*, which is concave in its upper part and convex

beneath, as shown at *B*, and the *cyma reversa*, which is convex above and concave beneath, as shown at *C*. The cyma recta is frequently seen as the crowning member of cornices, in which situation it acts as a covering, or hood, to shelter the lower members; on this account it is often referred to as a *crown molding*. From the slender aspect of the upper curve, it is not well adapted for use as a supporting member and is rarely so used, but its contour pervades all classic ornament as the outline of enrichment on flat surfaces and for the graceful lines of foliage where the same is either carved or painted upon the members of an order. The cyma recta is frequently ornamented with designs of the honeysuckle or other floral devices, which are carved in relief on the face of the molding, and not sunk beneath its surface, as was the custom of the Egyptians. The shadow cast by this molding is very sharp and black at the top and bottom, blending off towards the center, where the full strength of the light is shown.

72. The **cyma reversa** *C* has all the varieties of curve possessed by the former molding, but the tangent connecting the two curves is nearer horizontal, and the curves themselves are more deeply cut. It is more frequently enriched than the cyma recta, and like it may be found throughout all classic ornament; but it is particularly important in the capital of the Grecian-Doric column, where the subtle curve from the shaft of the column to the echinus of the capital is one of the most refined conceptions of the classic orders. The inverted outline of this molding conforms to the contour of the bases of the classic columns. Unlike the cyma recta, it is well adapted for use as a supporting member, and this expression of support is well exemplified in the Doric capital above referred to, where the weight of the overhanging architrave is so gracefully transmitted to the neck of the sturdy shaft. Both forms of the cyma are also known as the *ogee*, signifying a curve of contrary flexure.

The term *cyma* is derived from the Greek word *kyma*, meaning a wave, while the adjectives *recta* and *reversa*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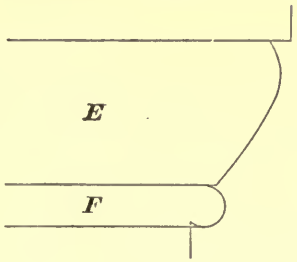
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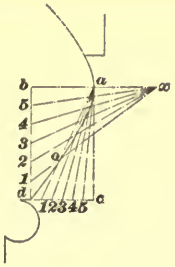
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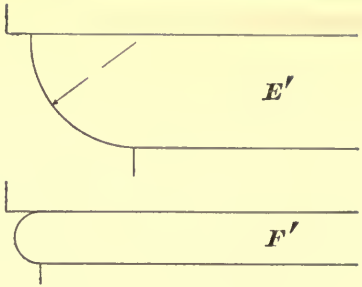
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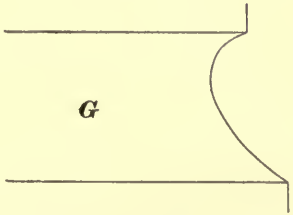
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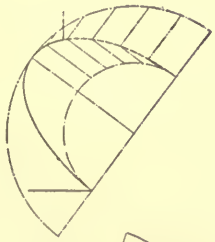

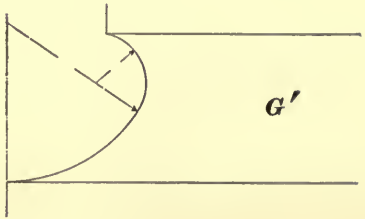
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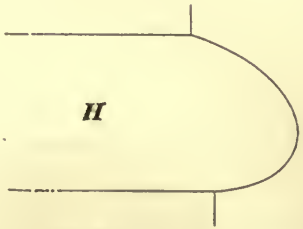
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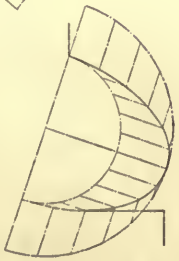

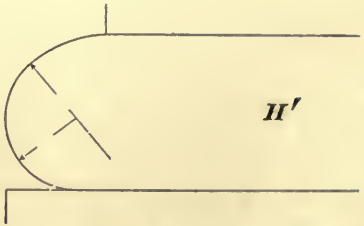
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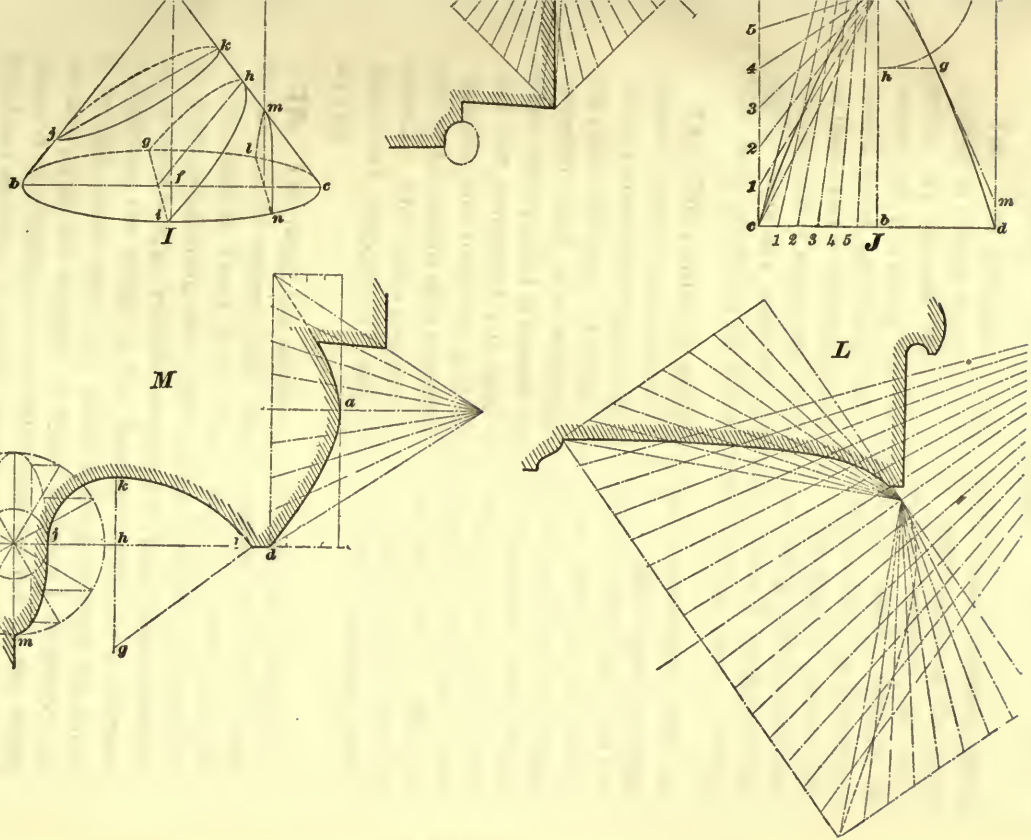

PLATE III.

define the position—the former meaning upright, and the latter meaning reversed, or opposite.

73. The **cavetto,** or cove, *D* is a concave molding whose outline is almost identical with the upper part of the cyma recta. It is used both as a crowning member and as a means of obviating the sharp angle which, without it, would occur between a facia and a fillet, but it is never seen in bases and is never ornamented. The shadow produced by the cavetto is sharp and black at the top, gradually diminishing in intensity until it disappears entirely at the bottom. The term cavetto is an Italian diminutive of *cavo*, a hollow.

74. The **ovolo,** or **echinus,** also sometimes called the *quarter round*, is shown at *E*; it is an egg-shaped molding whose outline corresponds very closely to the upper part of the cyma reversa. Its general contour pervades all classic ornament, and as a molding it always occupies a position above the eye and is almost invariably enriched with an egg-and-dart ornament cut into its surface. As a supporting member, the ovolo is well adapted and is frequently seen under the abacus of a capital or in the angle of the soffit of a corona. The terms *ovolo* and *echinus* are from the Latin and the Greek, respectively, and each in its own language means an egg.

75. The **bead** is a small rope-like molding, shown at *F*. Its section is rather more than a semicircle, and, though seldom used by itself, it is often found in connection with the fillet, separating two larger or more important members, or dividing a large vertical surface by a long broken shadow, as between the facias of the Roman-Corinthian architrave. It is also much used as a neck molding between the top of the shaft and the capital, in which position it expresses the function of binding and strengthening the top of the shaft. The bead molding is nearly always carved into a series of globular and disk forms, from which it derives its name.

76. The **scotia** *G* is a hollow molding, used almost entirely in the bases of columns between the fillets which

accompany the two torus moldings. Its contour is identical with a reversed ovolo, and it casts a deep, dark shadow, for which it is most frequently used in positions falling below the eye of the observer, where it thus contrasts and strengthens the effect of the adjacent moldings, while it gives much variety to the outline of the base. Its name is from the Greek *skotia*, signifying darkness.

77. The **torus** *H* is the principal molding used in the bases of the columns in all the five orders. It is rope-like in form, and when wound around the bottom of the shaft it gives, like the bead, an expression of binding strength. It is generally used twice in the bases, but is separated by a scotia, as stated above. The upper torus of a base is generally the smaller, and with the apophyge, or escape of the shaft, an inverted cyma reversa is formed, while the lower torus and the scotia form the same feature on a larger scale. This shows that the torus and scotia refer to the same principle when in composition, but they are never used together except in combination as a base. The shadow produced by the torus molding is very sharp and heavy at the bottom, graduating towards the top, where the full light falls upon it. Its name is from the Latin, and signifies a protuberance or swelling.

78. Grecian architecture is distinguished by the grace of its proportions and the beauty of its outlines, the latter being governed largely by the contour and projection of its moldings, while the spacing of these moldings determines the proportions and subdivisions of the height.

Roman architecture, on the contrary, is chiefly remarkable for the magnificence of its construction and the elaborate ornamentation of its details, without that delicacy and refinement which expresses itself in every line of the Grecian monuments. Roman moldings, though identical in name and similar in shape to their Grecian prototypes, are materially different in actual profile, owing to the different principles employed in establishing their contour.

The outlines of the Greek moldings will be found, in nearly every instance, to follow the curves of the conic sections, generally the hyperbola or parabola, occasionally the ellipse, and very rarely the circle.

The Roman moldings are, on the contrary, nearly always formed from the arcs of one or more circles, and for this reason their profiles are deficient in that expression of delicacy and refinement which characterizes the details of the Greek monuments.

Before analyzing the outlines of these Greek moldings and the methods of contouring them, let us first give our attention to the conic sections from which they seem to have been derived.

79. At *I*, Plate III, are shown two similar cones, *a b c* and *a d e*, which are in contact with each other at their vertices *a*, and whose bases *b c* and *d e* are circular and at right angles to the axes *a f* and *a f'*.

If either of the cones be intersected or cut by a plane, which is parallel to one of its elements or sides, as *b e*, the line of intersection will be a parabola as at *g h i*; but, if, instead of being parallel to the side *b e*, the cutting plane makes an angle with it, the curve formed by the intersection will be either an ellipse or a hyperbola, according to the angle. It will be an ellipse when the cutting plane is more nearly parallel with the base of the cone than it was in the case of the parabola, and passes through both sides as at *j k*; and the line of intersection will be a hyperbola when the cutting plane is more nearly perpendicular to the base than it was in the case of the parabola, as shown at *l m n* and *o p q*.

80. In the case of the hyperbola, the plane will always cut both cones, thereby giving two branches to the curve, and these branches will be farther apart as the cutting plane recedes from the axes of the cones. The nearer the plane approaches the axes of the cones, the straighter will become the sides of the intersecting curve, and as the plane recedes from the axes, the rounder and nearer circular will

be the intersection, though no matter how closely the curve of intersection may approach the arc of a circle, it can never become absolutely circular in form.

The hyperbola becomes two intersecting straight lines when the plane passes through the vertex; these two lines are most divergent when the plane is parallel with the axes of the cones, and gradually become closer together as the plane approaches a position parallel with the side of the cone, where the hyperbola reaches its limit in a straight line. This straight line is the common limit of both hyperbola and parabola, as any deviation from it will produce one or the other of these curves, according to the direction of that deviation.

As the plane of the ellipse becomes more nearly parallel to the base of the cone, the ellipse approaches the form of a circle, which it finally becomes, when the axis of the cone and the cutting plane are perpendicular to each other, as at *r s t*, and as the plane of the ellipse approaches the vertex of the cone the ellipse diminishes in size until it reaches its limit in a point. From a point to a circle, then, is the limit of curvature of the ellipse.

In *Geometrical Drawing*, methods are given in examples 23 and 25 for drawing an ellipse and a parabola of any desired proportions, and it is only necessary to add here the method of contouring the hyperbola.

81. To draw a hyperbola of a given width and height, the axis *a b*, at *J*, is laid down perpendicular to the width *c d*, in the same manner as for the parabola, and the rectangle *c d f e* is constructed with *c d* equal to the base of the hyperbola, and the height *c e* equal to the axis *a b*. Divide one-half the base and, also, each side into any number of equal parts, and connect the points of division on the sides with the vertex *a* by means of the lines *a 1*, *a 2*, *a 3*, etc. The points of division on the base are connected by lines to some point *x* on the line of the axis *a b* extended; the points of intersection of these two series of lines will determine points on the hyperbolic curve, taking the lines

in the order as they recede from point c; x can be at any distance above a, and the curved lines $a\,c$ and $a\,d$ will approach more nearly the curves of the parabola as the point x becomes more remote. On the other hand, the nearer the point x is to the vertex a, the more $a\,c$ and $a\,d$ will approximate to a straight line, and when points x and a coincide, the line $a\,c$ will be a straight line.

To draw a tangent to any point of the hyperbola, first draw a line from the desired point g perpendicular to the axis $a\,b$, and on the extended axis $a\,x$ describe the semicircle $a\,k\,x$, with a radius $l\,a$ equal to $\frac{1}{2}\,a\,x$; then with a radius equal to $\frac{1}{2}\,l\,h$, describe the semicircle $l\,k\,h$ intersecting $a\,k\,x$ at k; draw $k\,i$ perpendicular to $a\,x$, and connect $i\,g$; then will $i\,g\,m$ be the tangent required.

82. **Greek moldings** can be divided into three classes, according to the number of mathematical curves comprising their outline.

In the *first class*, composed of a single mathematical curve, generally a hyperbola or parabola E, Plate III, the point d, the direction of the axis $a\,x$, and the ordinates $a\,b$ and $b\,d$ must be determined upon before we can trace in the curve. If the curve is to be a parabola, the base $b\,d$ and the side $d\,c$ are divided into the same number of equal parts, and points on the curve are found by the method laid down in example 25 of *Geometrical Drawing*.

If the curve is a hyperbola, the base and sides are divided as before, and the point x is located on the axis from one-half to three and one-half times $a\,b$, according to the convexity desired. A good way to do is to draw the curve in very lightly, freehand, and draw any line, as $a\,1$. Then through the point o, where $a\,1$ cuts the freehand curve, draw $o\,1$ and extend it until it intersects the axis $a\,b$ extended; this point of intersection will be x, and by drawing the other guide lines the points may be determined through which a curve of the desired convexity can be drawn.

83. The *second class*, shown at C, is composed of two mathematical curves. We generally find a combination of

the hyperbola and ellipse united by a common tangent, of the parabola and ellipse united by a common tangent, or of two ellipses united by a common tangent.

When the molding is composed of the arcs of a hyperbola and an ellipse, as at *C*, the points *a*, *d*, and *g* must be determined before the molding is outlined. The hyperbola is then drawn through the points *a*, *d* in the same manner as for moldings of the first class, and the tangent *h f* is drawn through the point *d*; *g k* is drawn parallel to *h f*, and *d k* is drawn at right angles to *g k*. *g k* will then be one-half the major axis, and *d k* will be one-half the minor axis of the required ellipse.

When the molding is composed of the arcs of a parabola and of an ellipse, the procedure is the same as before, except as to the drawing of the tangent *h' f'*. After outlining that portion of the molding limited by the arc of the parabola, the distance *a' m'* is laid off equal to *a' b'*, and the line *d' m'* will then be tangent at the point *d'*. The ellipse is then drawn as in the previous case.

When the molding is composed of the arcs of two ellipses, the points *a''* and *g''* are determined and the point of tangency *d''* located before the curves are drawn; then *g'' k''* and *b'' a''* are drawn equal to one-half the predetermined major axis of the ellipses, and *d'' k''* and *d'' b''* are drawn equal to one-half the minor axis of the particular ellipse to which they belong. The ellipses are then outlined as before.

84. The *third class* of moldings, composed of three curves, generally the arcs of circles combined with the arc of an ellipse, is found almost entirely in the details of the antæ caps and especially in that detail known as the *bird's-beak molding*.

A section of the bird's-beak molding is shown at *M*, where the principal curve *a d* is the arc of a hyperbola. The curve on the under side *l k j* is composed of the arcs of two tangent circles, *k l* being described with the radius *g k*, and *j k* with the radius *h j*. The centers of both circles being on the line *g k*, they are tangent at *k*. The arc *j m* is a part of an ellipse.

The application of the curves of the conic sections to the cyma recta is shown at *B*, and to such members as the *facia* and *soffit* of the corona at *K* and *L*, Plate III; the methods used in profiling these outlines are precisely the same as above set forth.

85. Roman moldings are almost invariably profiled to the arc of a circle, or to the arcs of two tangent circles, thus giving them a feeling of harshness and lack of spirit.

Compare the three Greek outlines of the cyma recta *B* with the Roman form shown at *B'*. The Greek form, capable of unlimited variety through the use of the ellipse as at *a*, the parabola at *b*, or the hyperbola at *c*, is infinitely superior, by virtue of its grace and beauty, to the limited outline that can be obtained in the Roman form, where the contour is but two tangent arcs of the same circle whose radius is revolved alternately outside and inside the profile line. The same may be said of the cymæ reversæ *C* and *C'*, where the Roman form has always the same even curve, while the Greek outline *C* is ever changing and never monotonous from its commencement to its end. The cavetto *D* and the ovolo *E* possess the same difference from their Roman namesakes *D'* and *E'* as do the above mentioned cymæ, and, as can be readily seen, it is from the Roman form of the ovolo that the name *quarter round* is derived, its profile being exactly a quadrant of a circle.

The Roman bead *F'* is usually no more than an even semicircle in section, while the Greek form is fully three-quarters of a circle, the extra projection serving admirable to emphasize the line of junction between the molding and the surfaces from which it projects.

The Roman scotia and torus are each formed from the tangent arcs of two circles, as may be seen at *G'* and *H'*, while the Greek moldings of similar name are in profile the arc of some conic section.

There are examples of Greek torus moldings whose profiles are the arcs of circles, or of very broad ellipses, but these, with the bead and bird's-beak moldings, described

heretofore, are the only examples of circular profiles in all Grecian detail.

The beautiful graduation of light and shade upon the surfaces whose curve is a conic section was well understood by the Greeks, and it is in the rarest instances that we find them using the arc of a circle as an outline for any molding of prominence. Observe that at *M* the main curve *a d* is a hyperbola, but the portion undercut at *d k j* is so hidden and remote, that the arcs of circles were considered sufficient for its contour; while the finishing curve *j m*, which was to be more plainly seen, was formed from the arc of an ellipse.

While the various moldings can thus be profiled by geometric methods, such as have been shown, the student will find, as he advances in the art, that the most effective profiles can be drawn by the hand alone, directed by judgment and good taste.

INTERCOLUMNIATION.

86. Intercolumniation is the clear distance between the lower part of the shafts of any two columns in a colonnade; and, when columns are properly spaced, this distance will vary in different orders. In the Tuscan, for example, no great exactness of spacing is required, as there are no ornaments in the entablature to be spaced; but in the Doric order, the intercolumniation must be such that the triglyphs will occur over the axes of the columns, while in Ionic and Corinthian orders, the dentils and modillions will strictly govern the intercolumniations.

87. The ancient names of the most frequent proportions for intercolumniations are: *pycnostyle*, where the space between columns is $1\frac{1}{2}$ diameters; *eustyle*, where $2\frac{1}{4}$ diameters is the interval; *diastyle*, where the space is 3 diameters; and *aræostyle*, where the intercolumniation is 4 diameters. Still another and somewhat variable system of intercolumniation is the *systyle*, where the columns are spaced farther apart than in pycnostyle, but not so far apart as in eustyle. These rules may be varied to suit

circumstances, and are only laid down to give a basis upon which to systematize the intercolumniations of a colonnade or arcade, as will be demonstrated later.

88. As said before, the triglyphs govern the intercolumniations in the Doric order, and reference to Fig. 27 will explain more fully how this is. Here is shown a portion of an entablature of the Doric order with the columns *A* and *B* spaced in pycnostyle at *a*, where the intercolumniation is $1\frac{1}{2}$ diameters. The triglyphs *t* are spaced $2\frac{1}{2}$ modules, or $1\frac{1}{4}$ diameters, from center to center, and intercolumniation *a*

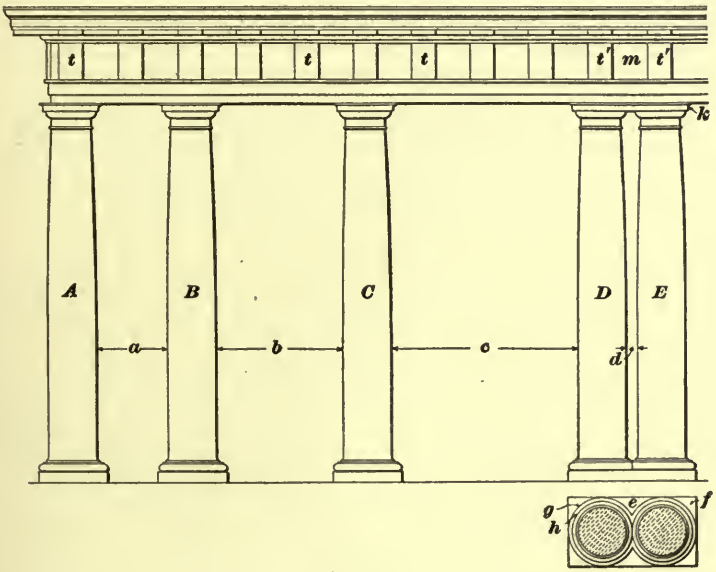

FIG. 27.

places the columns under every second triglyph, and $2\frac{1}{2}$ diameters from center to center, or $1\frac{1}{2}$ diameters apart. Intercolumniation *b* places the columns *B* and *C* under every third triglyph, which makes them $3\frac{3}{4}$ diameters from center to center, or $2\frac{3}{4}$ diameters apart. This intercolumniation is, therefore, diastyle, or nearly so, and is as close to three diameters as the columns of the Doric order can be regularly placed. Intercolumniation *c* leaves three triglyphs between

columns *C* and *D*, and as these triglyphs are $1\frac{1}{4}$ diameters on centers, the clear space between columns *C* and *D* is exactly 4 diameters, and is, therefore, araeostyle. As it is frequently necessary to couple two columns, as *D* and *E*, in order to give to a structure a proper expression of stability where the intercolumniations are great, as in the colonnade of the Louvre, shown in Fig. 106, *History of Architecture*, a rule for spacing them is laid down for each of the orders. In the Doric order, these columns are placed under the centers of adjacent triglyphs, which leaves the space *d* but $\frac{1}{4}$ of a diameter. This is so close that the tori of the two bases intersect at *e*, and the bases and plinth *f* are usually cut from one piece of stone. The astragals *h* of each base will just clear each other nicely, and the tori *g* are the only moldings that interfere; but the top moldings *k* of the abacus will be intersected by the same moldings of the adjacent capital, and the two columns must be joined by a continuous abacus or the intercolumniation be increased as explained below.

89. In a colonnade where the Doric order is used and the columns are coupled, as *D* and *E* in Fig. 27, the greater intercolumniation must be araeostyle and the intercolumniation *d* between the coupled columns may be 25 parts or $\frac{5}{12}$ of a diameter, in order to prevent the intersection of the tori of the base. The axes of the columns are then carried up and made the center lines of the triglyphs *t'*. The triglyphs *t'* are then each made 2 parts wider than their ordinary proportion, and the metope *m* is made 1 module and 18 parts in width.

These excesses cannot be discovered without very critical scrutiny, and are permissible as the only means of overcoming a great difficulty.

In the Ionic, Corinthian, and Composite orders, the deviation from the prescribed spacing, in order to insure axial centering of modillions, dentils, and other ornaments, is trifling, and in no case gives rise to any unusual difficulty. When coupled columns are used in either of these last named orders, their intercolumniation is generally 1 module, which is ample for projection of capitals and bases.

When there are modillions in the cornice, the intercolumniations must be so arranged that the axes of the columns and modillions will fall on the same line. If the modillions are 1 m. 10 p.* from axis to axis, the columns must be spaced under every fourth modillion to become $1\frac{2}{3}$ diameters apart, which is as near as we can come to pycnostyle. Under every fifth modillion they would be $2\frac{1}{3}$ diameters apart, or eustyle, and under every sixth modillion they would be 3 diameters apart, or diastyle, etc.

PEDESTALS.

90. Pedestals, strictly speaking, should not be considered as a part of an order; but in designing a building there are so many cases where pedestals cannot be dispensed with that it is perhaps advisable to give them consideration in connection with the column and entablature of the order in which they are used.

Thus, within our churches and cathedrals, if the columns supporting the vault or roof rested immediately on the floor, the seats would hide their bases and a good part of their shafts; and in our theaters, courts of justice, and other public buildings, where crowds frequently assemble, the same thing would be true, and we would feel justified in raising our columns on pedestals in order to preserve the proper effect of our composition. Then, again, when it is desirable to run a balustrade between two columns, it is a most inartistic practice to run the railing into the shaft itself, and the pedestal, if placed under the column, would be a suitable height for the railing to spring from, and if it is not, it should be raised on a plinth until it is of proper height.

In the extravagances prevalent in the interior decorations of the Renaissance period, we find the pedestal used under the pilasters in the wall decoration, and the dado, or wainscot, carried around the room the height of the pedestal as a

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*m. and p. are abbreviations of the terms *modules* and *parts*, as explained in *Advanced Architectural Drawing*.

sort of continuous stylobate. The die of the pedestal is then occasionally decorated with tablets or with sunken panels, whose margins are molded; but such practices are to be indulged in only after careful study and mature deliberation.

In each of the foregoing examples of the Roman orders, the proportions of the pedestal have been given in detail, and, as has been shown, the height of the pedestal is always exactly one-third the height of the column, including capital and base, while the entablature is always one-fourth that height. Suppose we have a monumental room the ceiling of which is 14 feet 3 inches high, and we desire to carry the entablature of an order around the side walls and support it on pilasters, at each side of each window and door, with as many intermediate pilasters as are required to give the whole an appearance of solidity; and we wish the pedestal to mark the height of the wainscot and the bottom of the sill of the window. Then the pedestal will be about 3 feet high, the column or pilaster 9 feet long, and the entablature 2 feet 3 inches deep. If 3 feet is not high enough for the wainscot, we would be justified in increasing the height of the pedestal by elevating it upon a plinth, or subbase, and decreasing the column and the entablature proportionately.

If, on the other hand, the ceiling is so high as to bring the pedestal above the desirable height for a wainscot, it is sometimes customary to have the cap of the wainscot a continuation of the astragal or necking of the pedestal, as is shown on the plates of the Corinthian and Composite orders.

ARCADES AND COLONNADES.

91. An **arcade** is a series of arches supported either upon square piers with columns attached (as in the Colosseum, at Rome, a portion of the facade of which is shown in Fig. 28), or carried upon the piers or columns alone, as at *a* in Fig. 29, which is a view of Madison Square Garden, in New York City.

92. A **colonnade** is a series of columns connected usually by lintels, or beams, and when surrounding an open

court is frequently referred to as a peristyle. The Madison Square Roof Garden is enclosed by a colonnade, shown at *b*, Fig. 29.

93. Where an arcade occurs in the facade of a building, as in Fig. 28, certain definite proportion must exist between the piers or columns supporting the superstructure and the superstructure itself. In the rule of this proportion, it will be found that the radius of the arch or the diameter of the opening is indirectly the governing measure of every detail of the arcade. In all such systems of colonnades and arcades two rules are to be observed: (1) *there must be an approximate equality of apparent mass between the weights and supports;* (2) *there must be a proportion of total void to total solid of about three to two.*

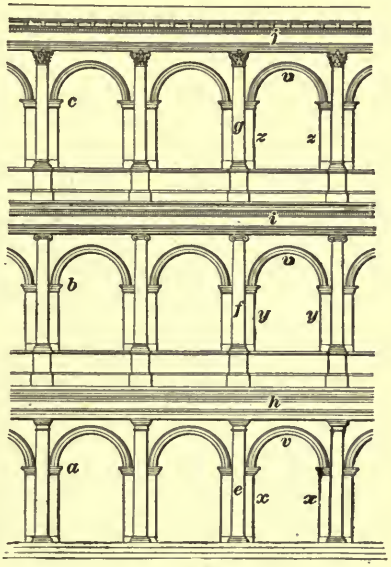


FIG. 28.

In explanation of this, let Fig. 30 represent an arch from an arcade in the facade of a building; then the portion *a e m f d c o b* is the mass representing the weight, while *a g h b* and *c i k d* represent the supports. Now, according to the first rule, *a e m f d c o b* should be equal to the sum of *a g h b* and *c i k d*. The line *g k* is divided into six parts, which serve as a scale to the diagram, the opening *h i* being four of them, the height *h b* is six, *n o* measures two parts, and *o m* one.

The surface of the weight *a e m f d c o b* is equal to $(a e \times e f) - (\text{area of semicircle } b o c)$, which is equal to $(a e \times e f) - \frac{b c^2 \times .7854}{2}$, or in figures, $3 \times 6 - \frac{4 \times 4 \times .7854}{2}$ $= 11.72$. The supports will be $(a b \times b h) + (c d \times c i)$, or in

figures, $1\times6+1\times6=12$, thus showing a comparatively even division of mass between supports and weights. Now, if we compare the weights and supports with the void they

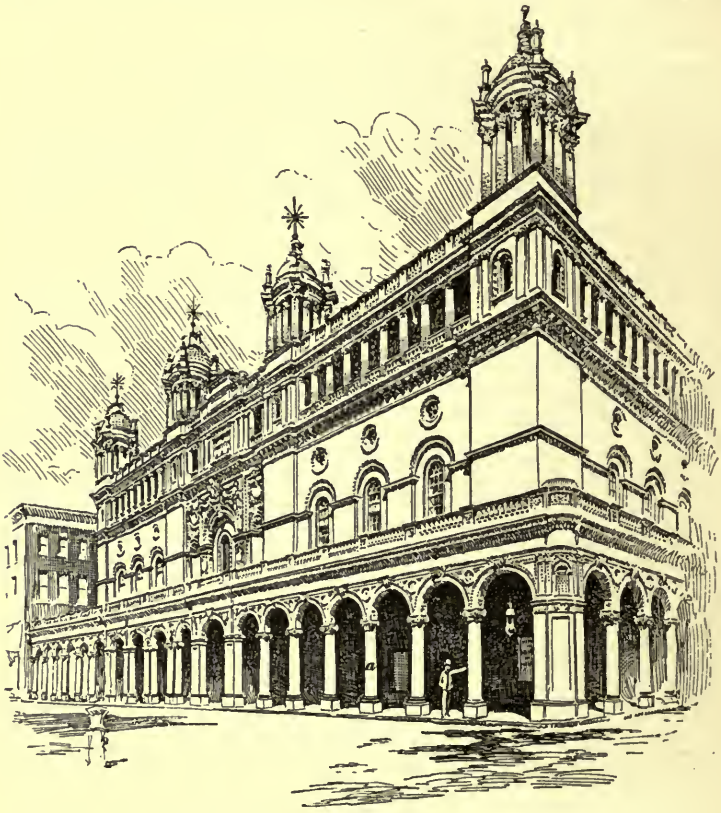


FIG. 29.

surround, we have the rectangle $h\,b\,c\,i = h\,b\times h\,i$, or $6\times4 = 24$, and the semicircle $b\,o\,c = \frac{4\times4\times.7854}{2} = 6.28$, the entire void being $24+6.28 = 30.28$. The total area of the solid is then $11.72+12 = 23.72$, or fully two-thirds of the void as set forth in the second rule.

94. In Fig. 31, which is a portion of a Doric arcade, the area of the void $a\,b\,d\,c$ is 10.5 modules$\times7$ modules, or 73.5

square modules. The area of the semicircle $= \frac{(7^2 \times .7854)}{2} = 19.24$, making the total void $= 73.5 + 19.24 = 92.74$. The area of the supports $= \frac{ghca + bdji}{2}$ $= \frac{3 \times 10\frac{1}{2} + 3 \times 10\frac{1}{2}}{2} = 31\frac{1}{2}$, and the area of the rectangle $yxwz$ $-$ semicircle $aeb = (10 \times 5\frac{1}{2}) - \frac{7^2 \times .7854}{2} = 35.76$, or total solid $= 67.26$; from this we see that the mass of the weight, 35.76, is very nearly equal to the mass of the supports, 31.5,

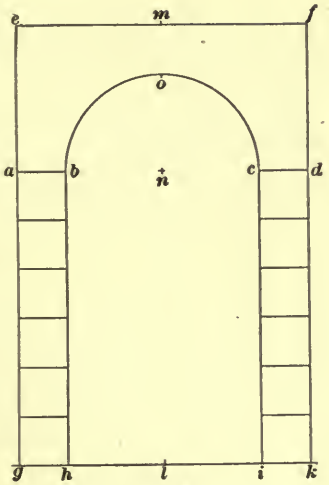


FIG. 30.

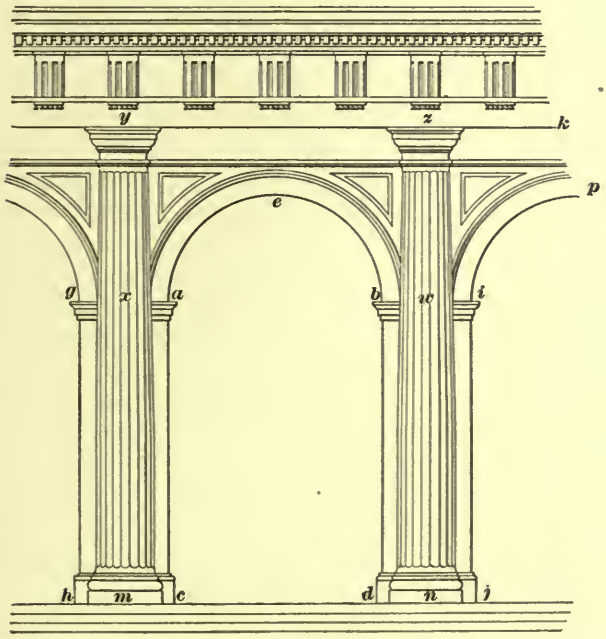


FIG. 31.

and that the sum of the weights and the supports, 67.26, is approximately two-thirds of the void, as required by the rules.

The entablature is not taken into consideration in making these calculations, as its apparent weight is carried by the columns x and w, which are practically separate from the piers which carry the arch, and are considered separately as follows:

95. In a colonnade where there are no arches, but simply a continuous row of columns connected by lintels, we have to consider the lintel as the weight and the columns as the support. Let $q\,r$, Fig. 32, be the height of a column, and $s\,l$, the distance between the columns, equals one-third the height, or two diameters. Now, if we divide $q\,r$ into four equal parts at a, b, and c, and the horizontal lines $a\,d$, $b\,e$, and $c\,f$ be drawn, and also if $s\,l$ be divided into four equal parts at g, h, and i, and perpendicular lines be drawn through them, the *void* $y\,s\,l\,z$ will be divided into sixteen equal parallelograms, one-half of which, or eight parallelograms, will be equal to each of the two supports $q\,r\,s\,y$ and $z\,l\,k\,j$. But we should consider only one-half of each of these supports, as in a colonnade each support would have to carry one-half of two arches or lintels, and conversely each arch or lintel would rest on two half-columns; therefore, the semi-supports are $o\,m\,s\,y$ and $z\,l\,n\,p$, and their sum is equal to one-half of the void $y\,s\,l\,z$. We will now consider the lintel, or weight, $t\,o\,p\,u$ on the supports and equal to them in mass. Another row of parallelograms $v\,o\,p\,w$ is raised above the semi-supports, but this row contains but six parallelograms, while the supports contain eight; it is, therefore, necessary to increase the lintel, or

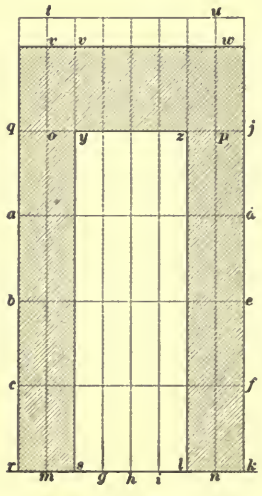


FIG. 32.

weight, in height till the area *t v w u* is equal to the area of two parallelograms. The increased height will be $\frac{2 \text{ parts}}{6}$, or one-third the height of one parallelogram. This will make the lintel, or weight, 1,333 parallelograms in height, or one-third the height of the column, which is the proportion of the entablature in the Grecian Doric, while one-fourth is the rule as laid down in the five Roman orders. The weights and supports are then equal, and their sum is two-thirds the area of the void.

The above proportions are for arcades and colonnades when they appear in the facade of a building as a part of the structure itself, as in Fig. 28; but, when the colonnade is simply used to support the roof of a loggia, or balcony, as in the Madison Square Roof Garden, Fig. 29, or as in the facade of the Louvre (Fig. 106, *History of Architecture*), the voids may be made much greater, and the design, if judiciously handled, will thereby assume a feeling of lightness which will be very pleasing.

Perrault, when he designed the colonnade of the Louvre, invented the intercolumniation above referred to as *arœostyle*, and in order to prevent the feeling of weakness that would appear in the facade of that structure, if there was but a single column at each point of support, he coupled his columns and gave to his structure that feeling of lightness combined with stability that makes the palace one of the most pleasing designs in the Renaissance style.

When the intervals between columns are increased beyond two and one-half diameters, the shaft of the column should be thickened beyond the proportions given for it under the rules for the orders, unless the columns are grouped in pairs as stated above.

96. A number of combinations of arches and square openings have been attempted by various architects to give variety to the effect of a long arcade, and though many of the designs are most ingenious, there is seldom a combination effected that is as imposing and dignified as

the simple repetition of the arch and its supports, as shown in Fig. 29.

Fig. 33 is from a design by Vignola, for the Villa Borghese,

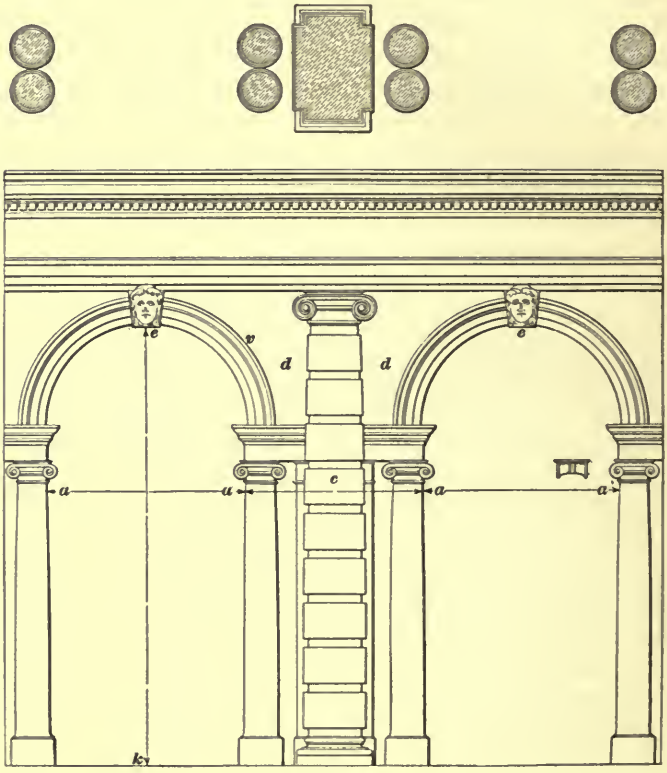


Fig. 33.

near Rome, and variations of it are much used in modern Renaissance work. The height *e k* of the arch is a little more than twice its width, while the breadth of the pier and columns *a*, *a* is a trifle less than that of the arch. A similar scheme in construction, but differing in the elements of its design, is shown in Fig. 34, which is from a basilica at Vicenza, designed by Palladio.

In either of these designs the weak point is at *a*, where the

weight of the arch and superstructure is concentrated upon the tops of the columns, which have no lateral support except the column *b* in Fig. 34, or the pilaster *c* in Fig. 33. Unless

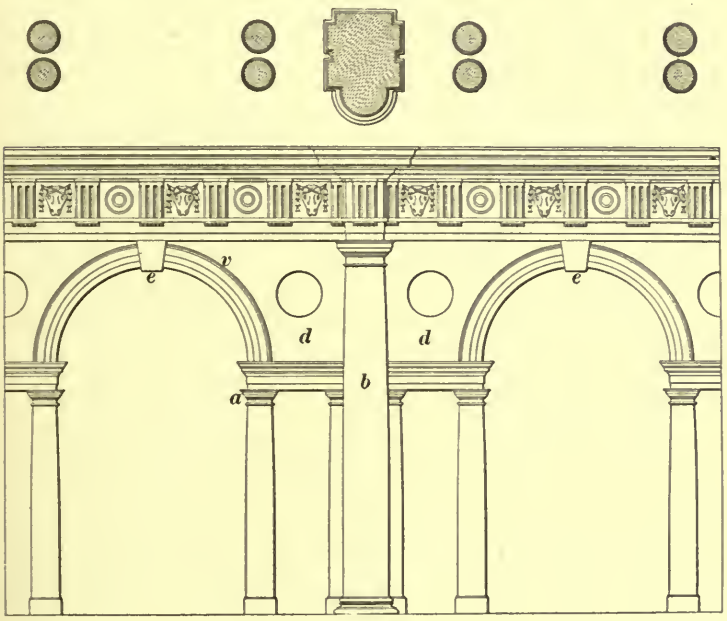


FIG. 34.

very carefully provided against, the wall *d* is liable to bulge forwards and cause a collapse of the building.

Far worse in this respect is the arrangement shown in Fig. 35, which, in various modified forms, is used repeatedly by both ancient and modern architects. In fact, its form was so much admired that we see it adopted as late as the eighteenth century, in much of the wood construction of the American colonial work. In this case the points *a* are so unstable that when the form is erected in stone, artificial means must be employed to anchor the angles at *a* back into the building and thus prevent the slightest bulging, which would be fatal. The width of the larger opening in Fig. 35 is four to six diameters of the column and about twice its width in height. The lesser opening is about two-thirds the

larger one in width, and its height is governed by the length of the columns.

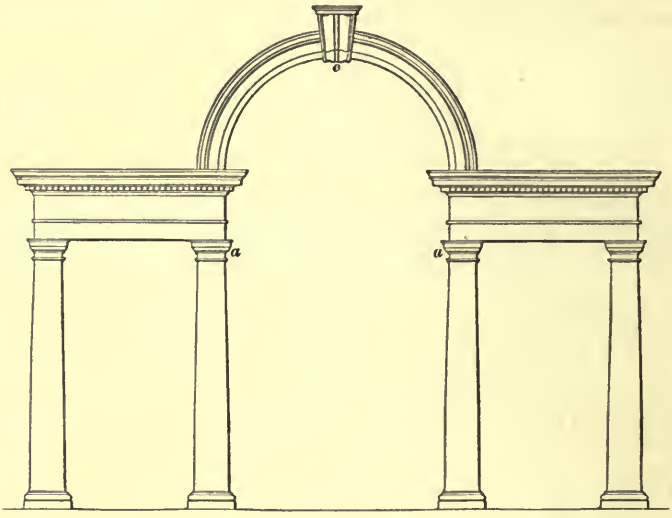


FIG. 35.

97. In addition to the specific rules above given regarding the proportioning of arcades according to equal weights and supports, the following proportions should be constantly borne in mind:

The height of the arch should be about twice its width. The width of the pier between the arches should not be less than one-half the width of the arch, nor more than the full width of the opening. The length of the small columns (where two orders are used, as in Figs. 33 and 34) should be about two-thirds the larger ones, and the width of the architrave *r* is equal to the top diameter of the small columns. The bottom of the keystone *e* is the same width.

SUPERCOLUMNIATION.

98. **Supercolumniation** is the placing of one or more columns or colonnades above another. The idea originated with the Romans, but even with them it was sparingly used.

The principal advantage of the arrangement is that a building may thus be divided into stories, and the order in each story will be less bulky than if it ran up through three stories, as was done by Palladio in some of his palaces at Verona. A column or pilaster 30 feet high would thus require a shaft 3 or more feet in diameter, according to the order of the design; whereas, if the building were composed of two orders, as was Inigo Jones's Banqueting Hall, or of three stories, as is the Louvre Palace, the columns would be but 1 foot or more in diameter. The Renaissance architects appreciated this fact, and after a number of more or less experimental buildings, they deduced the rule that the base of the shaft of the superimposed column should be of the same diameter as the neck of the shaft of the column immediately below it.

The Roman builders arranged their supercolumniations on the principle that the apparent area of the upper column should be one-fourth less than the apparent area of the lower column, and that superimposed columns should be arranged from the bottom up in the sequence with which the orders are usually named, i. e., from Tuscan or Doric through the Corinthian or Composite. In other words, the Ionic can be placed above the Doric order, but under no circumstances should the Doric be placed above the Ionic. In following out this rule, we find that when we make the upper order or column one-fourth less in apparent area than the column next below it, the base of the shaft of the superimposed order will be of the same diameter as the neck of the shaft of the column below, and our rule as laid down first is the one most generally followed, as it is simpler and brings about the same results.

In the last two plates of *Advanced Architectural Drawing*, we have the Ionic and Corinthian orders so arranged that they can be placed one over the other and form a design of superimposed orders. The diameter of the base of the shaft of the column in the last plate is the same as the diameter of the neck of the shaft in the previous plate.

PILASTERS.

99. **Pilasters** are square engaged columns or projections from the face of a wall, to carry a girder or the abutment of an arch, and they are designed in the same proportion of length to width as are the columns of the order in which they are used. The most common base is the form known as the *Attic base*, or a plain fillet and torus, as at *a*, Figs. 36 and 37,

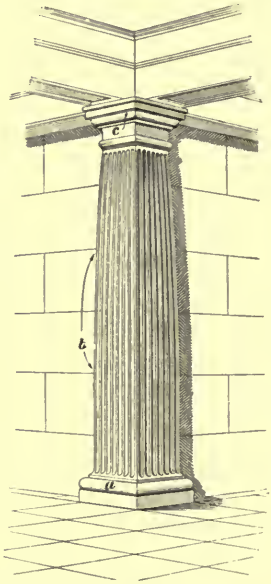


FIG. 36.

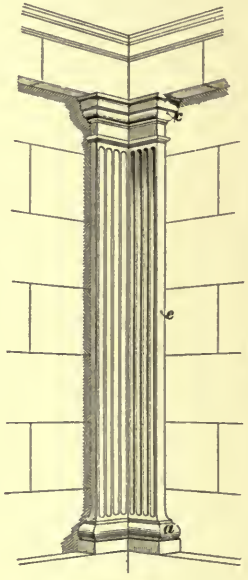


FIG. 37.

but the capitals differ widely even when they are used in connection with one or more columns of the five orders. Occasionally, the capital will be a modified form of the proper classic capital of the order in which the pilaster is used, but more often it is a series of plain moldings, more or less enriched according to the character of the edifice in which it is used. The moldings of the Tuscan and Doric capitals can be used very appropriately on a square pilaster as shown at *c*, Figs. 36 and 37, but the Ionic and Corinthian capitals have never been successfully transferred from the round column.

When a pilaster is used to support the wall end of an entablature whose outer extremity rests on a column, the sides of the pilaster diminish with entasis in the same manner as do the sides of the column, as shown at *b*, Fig. 36; but when no column is present, the pilaster is straight and its sides are parallel and perpendicular to the base, as shown in Fig. 37.

100. Pilasters should project from the face of the wall in proportion to the work they have to perform; those designed to carry lintels or arches project from one-half to two-thirds their widths, while others, as referred to in Renaissance work, which simply perform the functions of dividing a wall into panels, need stand out but one-quarter, or even one-fifth, their width.

In the Pantheon, at Rome (see Fig. 32, *History of Architecture*), the pilasters forming the ends of the walls between the niches projected but one-fourth of their diameter. But as these columns and pilasters were nearly 40 feet high, this small proportionate projection was quite sufficient to define their outline, which was all the occasion required. Pilasters are made plain, fluted, or paneled, according to their material and to the surrounding circumstances. In the portico of the Pantheon the columns were left plain and the pilasters were fluted. The cause of this is evident, as the columns were of granite and the pilasters of marble; the former material is very difficult to cut, while the latter is easily worked.

When pilasters are fluted, either seven or nine grooves should be the number, according to the practice of the ancients, except where a pilaster is returned on the angle of an inside corner, as in Fig. 37, in which case four or five should be cut on each half to avoid bringing a flute into the angle. When a pilaster is returned on an exterior corner, a full-width face is shown each side of the angle, as shown in Fig. 36. When pilasters project less than half their diameter, their return faces are not fluted, as shown at *e*, Fig. 37.

IMPOSTS.

101. Another supporting detail used with the orders is the **impost,** which, though somewhat akin to the pilaster, is entirely different from it, and is used only in connection with arcades. In Fig. 31 is a portion of a Doric arcade, where the entablature *y z k* is supported upon the columns *y m* and *z n*, and the arches *a e b* and *i p* are carried by the *imposts g*, *a*, *b*, and *i*. An impost, therefore, is a group of moldings at the top of a pier or pilaster, to receive the abutments of an arch.

In classic architecture these impost moldings were differently grouped in the different orders, and were measured in terms of the module of the order in which they were grouped; Figs. 38 to 42 show these moldings as they were grouped in each of the orders, and the proportions of each one in terms of the module of its order. In classic structures, and also in most of the Italian Renaissance edifices, the piers and moldings of the facade are proportioned in the terms of the module of the order used in its erection. There may be neither columns nor pilasters in the facade, but the cornice is proportioned as though there was a complete order in the composition; and, if a series of arches constitute one story of the facade, their imposts are molded in the terms of the order which governs the arcade.

Fig. 38 is the impost used in the Tuscan order, and is as

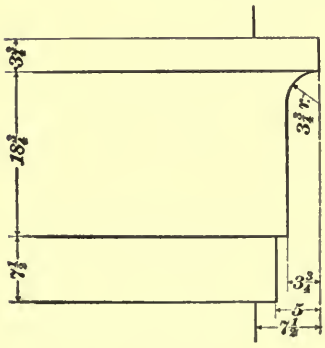


FIG. 38.

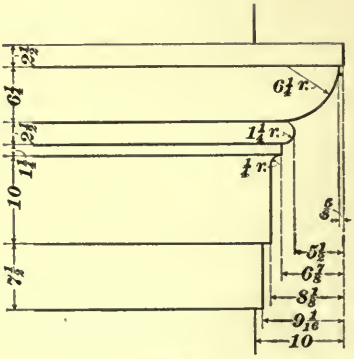


FIG. 39.

simple and severe as are the other details of that order. Fig. 39 is the impost corresponding to the Doric order, and

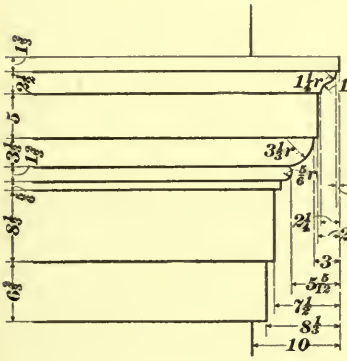


FIG. 40.

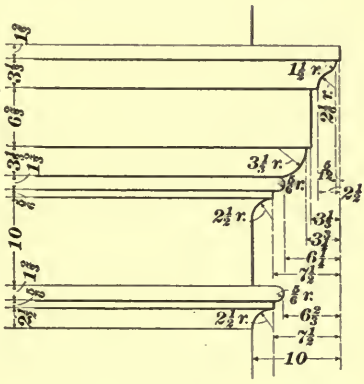


FIG. 41.

though consisting of more members than the former, it is still very simple and unpretentious. Fig. 40 the Ionic, Fig. 41 the Corinthian, and Fig. 42 the Composite, imposts, are much more elaborate than the Tuscan and Doric, and vary one from the other only in a slight degree, as is shown by the figures giving their proportions. However, each should be used only in connection with the order to which it is attached, as these lines of molding were adopted by the ancients only after mature deliberation as to what was best suited to the style. Fig. 28 shows the Doric, Ionic, and Corinthian orders superimposed in the facade of the Colosseum, and at *a*, *b*, and *c* are the imposts of each order, as distinct from one another as the orders themselves.

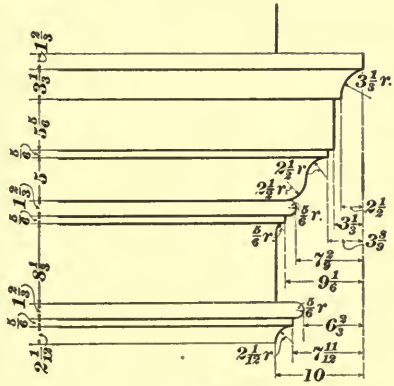


FIG. 42.

BALUSTERS.

102. A **baluster** is a species of column used to support a cap rail or hand rail, and is part of an ornamental railing placed in front of windows, or on the sides of stairways, enclosures for balconies, etc.; its primary purpose is to protect the occupants from accidents. A balustrade is essentially a series of balusters with base rails and cap rails and may be placed between columnar pedestals or have independent angle and intermediate piers to strengthen the construction, and should always partake of the general characteristics of the edifice of which it forms a part.

The general rules to be observed in designing a balustrade are that the balusters should be odd in number, and the distance between them should be equal to half their larger diameter, from which will result an approximate equality between the open and solid spaces. The whole height of the balustrade should be divided into thirteen equal parts, of which the height of the baluster is eight parts, *a*, Fig. 43, that of the base *b* is three parts, and of the cornice, or rail, *c* is two parts. Balustrades intended for actual use in a building, such as balusters used on stairs, before windows, or enclosing terraces, should not be less than 3 feet nor more than 3 feet 6 inches in height, but when used merely for ornamental purposes, as in crowning an entablature on a building, the balustrade should bear some proportion to the parts of the building. It should never exceed four-fifths of the height of the entablature on which it is placed, and it should be placed upon a plinth, if necessary, to raise it so that the entire balustrade can be seen from the best point of view for the building itself; and in such a case the balustrade must not be less than two-thirds the height of the cornice. When a balustrade fills in between two pedestals,

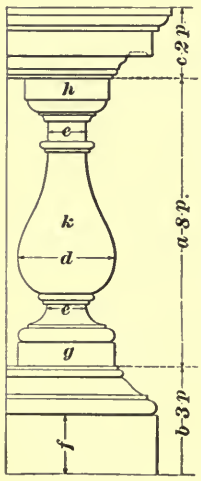


FIG. 43.

its height, of course, is regulated by the height of the pedestal, as is explained in connection with the dado, and all rules governing the proportions of pedestal and wainscot will apply equally to the balustrade, where it is employed in the same situation.

103. The baluster varies in shape and proportion of thickness to length of shaft, according to the order in which it is used. Unlike the column, it has practically no weight to support, and its bulk is only varied to make it conform with the order wherein it exists. The two last plates of *Advanced Architectural Drawing* show two examples of balusters, wherein the general outline of the one in the last plate is similar to the one in the previous plate, but doubled and placed with the two bases butted together in the middle. The plinth *g* and abacus *h* of a baluster (Fig. 43) are always square, and the shaft, or, as it is sometimes called, the *vase k*, is nearly always round; sometimes, in the Tuscan order, the vase is made square also, but only when the Tuscan is used in its rustic form and the column is built of alternating square and round courses.

The thickness of the baluster *d* at the heaviest part of the vase is, in the Tuscan, equal to three of the thirteen parts into which the whole height of the balustrade is divided, and in each of the other orders it is less, but varies according to its position and the service for which it is employed, whether useful or ornamental. At *e*, the slender portion of the baluster, the thickness should never be less than one part and seldom much more. The width of the plinth *g* is equal to the diameter of the vase at *d*, but the width of the abacus *h* should be about one-seventh less.

DOORS AND WINDOWS.

104. The arrangement of the doors relative to each other and to the various internal passages of a house is discussed elsewhere, and we will confine ourselves here to the discussion of doors and windows with reference to their relative

proportions. There is no fixed proportion for window openings, their sizes depending almost entirely upon the climate and clearness of the sky likely to prevail in the country where they exist. In the hot southern countries of Europe and America the windows are small and few, whereas, as we come north, we observe an increase of size and number as the days grow shorter and the sun is less glaring and objectionable. Therefore, the size of windows will depend entirely upon the architect's idea of what is best adapted for the position and locality.

It is very important that the exterior grouping of windows should be well considered; for, while it is not necessary that the two sides of an elevation should be absolutely symmetrical, it is desirable to have each window show for itself just why it is placed in its particular position. The windows in an elevation are the keys to the interior arrangement of the house, and their treatment and decoration should not be such as would lead an outsider to take the sash on a stair landing for a window of a parlor or library. In Renaissance work it is customary to treat the windows with columns or pilasters, as in the Farnese Palace shown in Fig. 94, *History of Architecture*, but great care must be exercised in this, as the order, if introduced in too heavy proportions, will render the facade clumsy in composition.

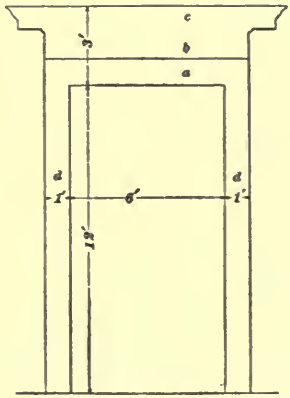


FIG. 44.

105. Architecture does not depend on arbitrary laws, and the rules laid down by the ancients were such that, in the best periods of art, they not only prevented the artists from falling on either side to excess, but gave them full liberty to use their talent and inventive genius to the fullest extent. In Fig. 44 we have the outline of a door with its architrave *a d*, frieze *b*, and cornice *c*. Its proportions correspond with those usually

adopted; that is, its height is twice its width, and the entablature is one-fourth the height of the opening, and the architraves *d* on each side are each one-sixth of the width. The opening, therefore, measured in terms of the width of the architrave, is 6 parts wide and 12 parts high, and its area is, consequently, 72 parts. Now, it will be found that the solid parts are exactly two-thirds of this area, thus showing the analogy between the columns and the entablature of an arcade, and the architrave and cornice of a door opening, and the reason for the definite proportions of parts in the details of the door and trim. All gates and doors must, independent of all other considerations, be of sufficient size for convenient passage through them; hence, internal doors should never be reduced below 2 feet 6 inches in width, and 6 feet 8 inches in height. Three feet is a good width for an inside door, and its proportionate architrave would then be 6 inches. Therefore, on all inside doors approaching this width it is customary to design a 6-inch trim throughout the house. But on a monumental doorway 6 feet wide and 12 feet high, we would require a full 12-inch architrave, as shown in Fig. 44. These are minimum dimensions for ordinary houses, but for more pretentious dwellings and for state apartments in mansions and hotels, widths of 4 to 6 feet, with folding doors, etc. of proportionate heights, will be nearer the appropriate sizes.

MEDIEVAL PROPORTION.

106. We will now consider a style of architecture entirely different from every principle and proportion which we studied in the classic orders. Gothic architecture bears not the slightest resemblance to anything which preceded it; but, like the Egyptian and Greek in one respect, it is absolutely original. The builders of the middle ages invented methods and systems, and did not take them by inheritance from their ancestors, as the Romans did, nor

dig them from the débris of antiquity, as the Renaissance architects did. During the transitional, or Romanesque, period, already described, the guilds of freemasons increased in strength and power until the building of the great cathedrals was entrusted to their hands entirely.

The formation of a secret society for masons and craftsmen was found necessary, in order that duly qualified artisans might secure work in strange cities, to the exclusion of incompetent impostors. The schools of artisans established by the church were open to all believers in the true faith, and, having served their apprenticeship under the tuition of the most experienced builders, the artisan or craftsman started out in the world to some cathedral-building city or monastery, and applied for work. Certain secret signs and passwords were all that were necessary to inform his new master how far he had progressed in his trade and to what grade of work he was best fitted. The more expert he became with his tools, the higher he was advanced in the masonic order, and as each degree of advancement had a different password, he could enter another district and secure work on another ecclesiastical edifice at exactly the same grade where he left off. Masonry thus became a powerful secret order, and the discoveries made in details of design and construction remained secrets with the craft. Many of these secrets were lost when the extensive building operations of the fifteenth and sixteenth centuries demanded more masons than the guilds could produce, and the constant employment of outside men uprooted the necessity of freemasonry, and the organization apparently died out. Among these lost secrets were the principles of the proportioning of the medieval cathedrals and abbeys, and the system of contouring the Gothic moldings—a system, of the existence of which ample proof exists, as there are many cases of duplicates of archivolt moldings, as much alike as though they were executed from the same drawing, though the two similar examples are as far separated as France and Scotland.

Modern research has succeeded in unearthing a portion of

these methods. It has been demonstrated, and is accepted now, that certain combinations of the circle, triangle, and square are the fundamental principles of the proportion of not only medieval moldings, but also of the cathedrals, abbeys, monasteries, and structures of every class and kind built during the Gothic period.

107. In order to better understand these principles of medieval proportion, it will be necessary to consider for a moment the system under which these enormous buildings were erected.

Architects, as such, did not exist in those days, and the plans for our great cathedrals were never drawn out in detail as in working drawings. The bishop or other ecclesiastic in charge of the building operations simply furnished an idea of the size and location of the desired edifice. He was a master mason himself, and perfectly capable of superintending all the details of construction, but each individual workman had full charge of his own particular work, and continued at it until his task was completed. Each mason understood perfectly all the complications of geometry necessary to cut his arch stones properly, and did his work so well that there are few cases known in all the medieval cathedrals where the work failed to fit or to come out properly.

108. The proportion of length, breadth, and height was often determined by a relation involving a combination of the square, triangle, and circle, and the square and its diagonal; the cube and its sides appear also to have furnished a unit of measurement in a similar manner. The development of the surface of a cube, according to the rules of descriptive geometry, produces the figure of a Latin cross, as shown in Fig. 45, which is the general form of all our medieval cathedrals. The so called magic numbers, which were used

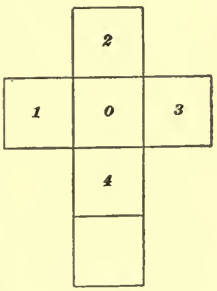


FIG. 45.

as a unit upon which to base the proportions of these great edifices, were probably 3, 5, and 7.

The first of these is exemplified in the crucial form, Fig. 45, by the three squares forming the apse and the two transepts; the second number is exemplified in the five squares forming the entire crucial figure with the exception of the central or inside square *0*, and the third number is acquired by counting the squares in each direction.

Winchester Cathedral, Fig. 76, *History of Architecture*, exhibits the existence of these figures, as applied to the proportioning of its plan, much more practically than explained above. The extreme length of the church, exclusive of the lady chapel, is five times the width. The transept is in length a trifle less than five times its width, while the projection of the transept from the walls of the nave is one-seventh of the total length of the nave. The height of the nave is one-seventh its length, and, if divided into fifteen parts, seven are given to the lower arches, three to the triforium, and five to the clerestory.

Thus we see that there is little doubt that the three above mentioned numbers had a strong influence in the proportioning of many of these cathedrals, as many other instances can be cited where the same apparent rules will apply.

109. The nave of Amiens Cathedral, in France, is proportioned somewhat differently, but none the less on geometric rules. Fig. 46 is a diagram showing the nave of the cathedral as standing within a cube *a b c d e f*. Each face of the cube is divided into thirty-six equal squares, and the bases of the nave piers *g* are placed at the intersections of the lines forming these squares on the under side, or base, of the cube. The height of the piers will then be two squares *g h*, the pointed arches will extend one square higher *h i*, the triforium will then occupy one line of squares *i j* above the arches, and the clerestory will take the two remaining squares *j k* to the top. Observe, also, that the width of the aisle *g l* back of the nave arches is equal to just one square, and that the thickness of the wall and buttress *l f* and *l e* is

one square more. The exactness with which this result is attained leaves but the slightest possible doubt that Amiens Cathedral was proportioned on the principle of the cube and

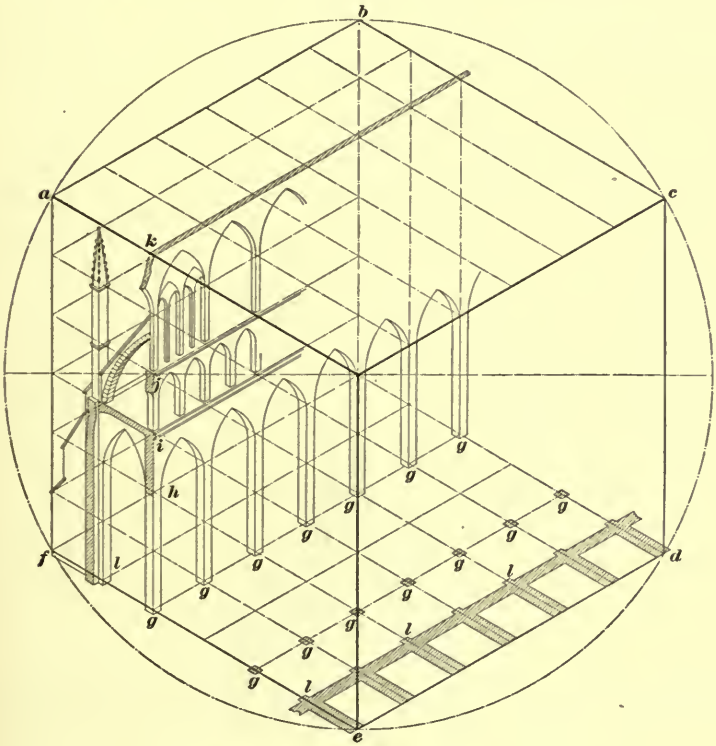


FIG. 46.

we shall see as we proceed further that the details of the molding, windows, tracery, groinings, etc. are all governed by some unseen law in geometry.

110. In Great Britain the heights of the vaults seem to have been determined upon a system of triangles. Salisbury, Worcester, Litchfield, York, Hereford, and a number of other cathedrals were probably vaulted upon the system shown in Fig. 47. Upon a given line *c a b* distances are laid off to the right and left of the center *a*, equal to the distances

of the piers of the vaults from the center line of the nave *A*, and equilateral triangles are then erected with these points limiting their bases. The apex of each of these equilateral triangles will then mark the height of a vault. In Fig. 47, *a d*, *a f*, and *a g* represent the distances of the nave columns *h*, the aisle columns *i*, and the wall *j* from the center line

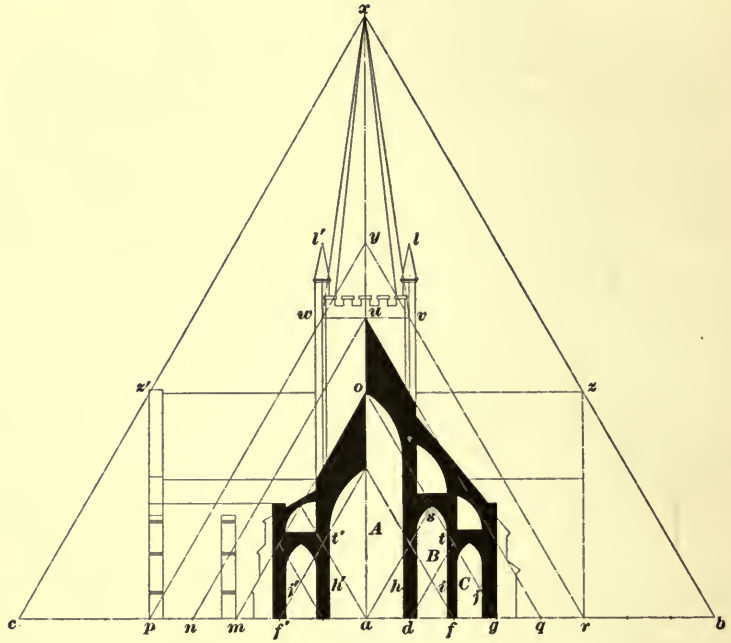


FIG. 47.

a of the nave *A*. Now, if we make *a m* equal to *a g* and erect an equilateral triangle *m o g*, we will have the apex of this triangle *o* for the crown of the vault over the nave *A*. The apex *s* of the equilateral triangle *a s g* marks the height of the aisle vault *B*, and the apex *t* of the triangle *d t g* marks the height of the vault *C*.

On the right side of the center line *x a*, this diagram defines the governing points for a five-aisle church, and, upon the left side, the same arrangement for a three-aisle church.

The tower and spire *v w x* are for the three-aisle half of the plan where the equilateral triangle *n u q* marks the height of the tower roof, when its base *n q* is equal to twice the width of the church. The apex *y* of the triangle *v u y* determines the height of the pinnacles *l* and *l'*, and the sides *y w* and *y v* if prolonged will intersect the base line at *p* and *r*, or at a distance equal to *a d*, from *n* and *q*. If the transept *z z'* is extended to this point and another equilateral triangle *b x c* be constructed so that its sides touch the gable points *z* and *z'* of the transept, then the apex *x* will mark a desirable height for the spire.

The idea here is not to give the student a regular system to measure and draw Gothic details, as was done with the classic work, for that system has never been discovered, but enough has been proved, as is described above, to show that such a system existed, and that these noble monuments of the dark ages were not the results of guesswork. Therefore, in designing a small church or a big cathedral, the architect of today has the same task before him, and his first move should be to develop a system on which his work can be carried forward.

WINDOW TRACERY.

111. In *History of Architecture*, window tracery is discussed briefly with regard to its value as a key to the date of the building, or the period of the architectural style. We will now consider its constructive features and the elements of its composition. The circle, square, and triangle form the basis of all tracery designs in the early English period, but the pentagon, hexagon, octagon, and

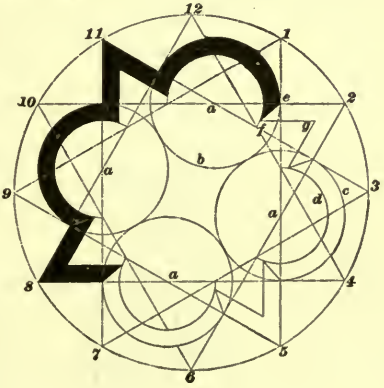


FIG. 48.

other polygonal forms each played a part as the style advanced.

112. In one of the window heads of the cloisters at Westminster Abbey, the date of which is about 1348, we find two figures that resemble the plans given to clustered columns, indicating that the same principles were applied to setting out both windows and points of support. When the circumference of a circle, Fig. 48, is divided into twelve equal parts, the dividing points form the apexes *1*, *2*, *3*, *4*, etc. of four equilateral triangles, and we have at their intersection *a*, not only the centers of the circles *e b* that are to constitute the form of the filling-in, but also the necessary miters *e f* and other parts of the figure; the width of the bar is *c d*, and all bars are drawn parallel to the construction lines.

The heavy black outline shows the design of the above mentioned window head, and comparison with Fig. 66 exhibits the close resemblance of this outline to that of the pier plan of the same period.

These geometrical rules were evidently applied to windows and to tracery of every description executed at the end of the thirteenth or the beginning of the fourteenth century; also, to the plans of the main clustered pillars in many churches and cathedrals.

113. For over a century, circles and their intersections formed the ornamental portions of every kind of panel as well as window head; they were afterwards blended into other figures, and apparently set out upon different principles, but the hexagon and equilateral triangle were necessary to produce the flowing lines which succeeded. The change which took place in design arose from the facility which had been attained by the practice of this method, and is ample evidence of the inventive power of the freemasons, and the progressive improvement in their school for depicting form. Windows are divided into two, three, or four *days*, as the openings for the admission of light are called, in distinction from the *mullions*, or solid bars, which separate them; and the upper portion, when enclosed in an equilateral triangle,

furnished opportunities for the production of designs of unlimited variety and singular beauty. In the more simple examples, there are three days, or lower divisions, as shown in Fig. 49, and the head is occupied by three circles *t m n*, *e h i*, and *h n l*, each of which contains a trefoil or a quarterfoil. *a*, *b*, *c*, *d* are the centers from which the side arches, as *c f d*, are described; *u* indicates the position of the centers for the central arch, whose apex is at *v*; *p* and *q* are the centers for the main arch *p o q*; *g*, *k*, *j* are the centers of the three circles; *s* is the center for the transition curve *i r*; the curve *e f* is described from the center *c*. In the highest development of the early

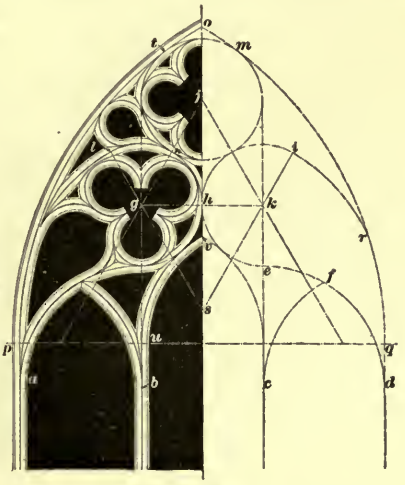


FIG. 49.

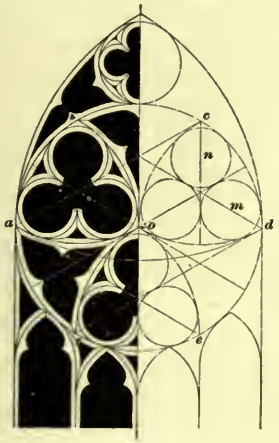


FIG. 50.

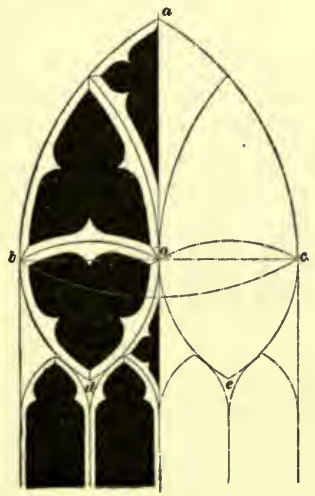


FIG. 51.

English period, these lines of tracery were as free and capricious as the running vine, but they were all constructed on geometrical principles, and the lines which tended to confine or stiffen the design were omitted.

114. Windows of four days, Fig. 50, are sometimes constructed with one large circle in the head *a b c d e f* divided into three equilateral triangles *a o b*, *o d c*, and *f e o*, each enclosing a trefoil *m n o*; or sometimes the head consists of one equilateral triangle *a b c*, Fig. 51, with two smaller ones *b o d* and *o c e*, constructed on the points of its base *b* and *c* and dropping into the spaces *d* and *e*, comprised between the heads of the divisions below.

115. Windows of six days are far more complicated, but, though exhibiting greater skill in geometry, they are set out precisely upon the same principle. Two equilateral triangles *a b c* and *d e f*, Fig. 52, enclosed within the great circle in the window head *a e b d c f*, mark out the prominent features of the design, and their terminations *a*, *f*, *c*, *d*, *b*, and *e* are the apexes of the spherical triangles *e g h*, *d i l*, *b k j*, etc., which by their crossings constitute the filling-in.

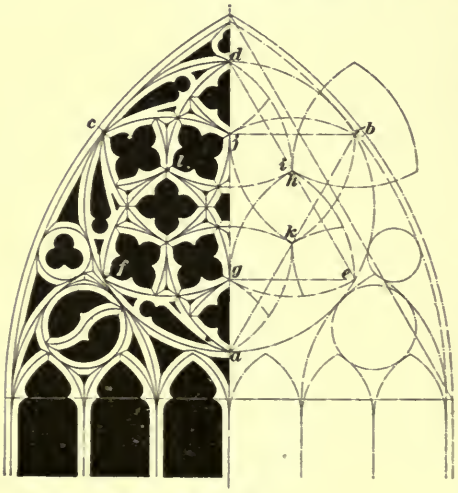


FIG. 52.

In some examples, above the two main lower divisions of the window, *a b c* and *d c e*, Fig. 53, a circle whose center is at *o* and whose diameter is equal to half the width of the window, is drawn, and its circumference is divided into twelve parts, *1*, *2*, *3*, *4*, *5*, etc.; and smaller circles, tangent to

one another and to the circumference of the great circle on its interior, are described in each.

FIG. 53.

At the close of the fourteenth century, these designs were so numerous that almost every cathedral and church had its own peculiar windows, but the general principles of setting out the work are identically the same everywhere. The circle and the equilateral triangle were subdivided almost to infinity, and at no time during the entire history of the arts do the mental faculties of the people seem so fertile as at the close of the fourteenth century, which we are now considering.

116. The form and magnitude of the several mullions used to divide these windows into days were also determined by means of the equilateral triangle. A line drawn from the apex of one mullion *a*, Fig. 54, to the apex of the other mullion *b*, forms the base of an equilateral triangle *a b c*, about which is drawn the hexagon *a d c e b f*, and with *d e* as a base another equilateral triangle *d e f* is drawn within the hexagon. The interior hexagon *g h i j k l* is then divided into six

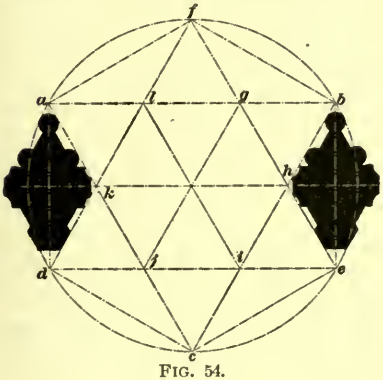


FIG. 54.

triangles, each one of which is equal to the area of half a mullion, and the lozenge shape which two of these triangles form when placed back to back is the outline enclosing the moldings of the mullion bar of the window. Of the twelve equilateral triangles embracing the two half mullions, ten are given to the day, or space to admit the light, and two, or one-sixth the whole, are given to the mullion. This is very nearly the proportion observed in all cases throughout the middle ages.

117. The pointed arch, as has been said before, was the direct development of efforts of the Romanesque builders to build permanently with the materials they had at their disposal. Notice how in the earliest stages of this struggle for stability, there was no attempt to produce elaborate ornament, but, on the contrary, every effort of mind and might seemed concentrated upon the desire to build permanently; and it was only after this desire had been satisfied and its purpose had been accomplished, that the architects, freed from this struggle and uncertainty, allowed their thoughts and inventive genius to run in lighter channels and convert every form in nature, with which their God had blessed the earth, into an ornamental figure for the embellishment of their new construction. The once stern, cubical capitals now become light and lively with animal and vegetable forms; running vines, bunches of flowers, leaves, fruits, and even dry branches, formed parts of the designs taken from the vegetable world, while beasts, birds, fishes, and reptiles were freely imitated in many of their carvings. Early Gothic architecture thereby was simply an ornamented construction, and every groin, capital, column, or buttress was built in its place because its presence was absolutely necessary, and never simply to look pretty. The same ideas should be observed in designing a Gothic structure in the present day. Construct the building to stand, proportion its parts to stay, pierce the walls where necessary, and then, but not till then, let the ornamentation be considered.

MEDIEVAL DETAILS.

ARCHES.

118. At the end of the twelfth century and in the beginning of the thirteenth, the first condition in order to arrange the plan of an edifice was to know whether it was to be vaulted, and, if so, in what way. It was then necessary, as soon as the number and directions of these vaults were determined, to make drawings of their bases which rested upon the capitals of the columns; for the outline of these base blocks determined the shape and dimension of the abacus and capitals, as well as the number, sizes, and positions of the vertical supports. This method of working will at first seem strange, as it appears to be deriving the ground plan of the

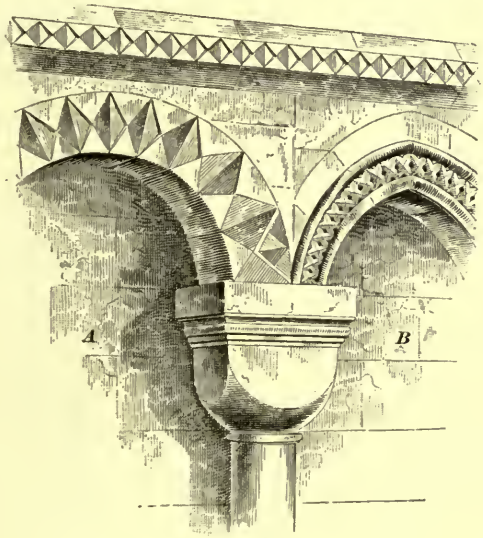


FIG. 55.

building from the design of the roof or vault, but it is perfectly rational. The medieval builders wished to cover a surface, and to do it they proposed to fix vaults upon points of support; therefore, the principal object was the *vault*, and the points of support were only the means of holding it in place,

and their position on the plan could be changed only through a change in the form of the vault itself.

Medieval arches and vaults, as has been shown, are different in kind, different in principle, and different in construction from those we have seen in the Roman structures, and all these points of difference are the results of attempts to overcome difficulties; therefore, it is not at all surprising to find them enriched by an entirely different system and style of ornament.

119. The early Romanesque arch was semicircular and absolutely plain, except in a few places where a *chevron* or dog-tooth ornament was cut in with an ax. As the style advanced, and the pointed arch came into use, the carved work became finer, owing to the use of the chisel instead of the clumsy ax, as shown in Fig. 55, which is a part of an arcade at Canterbury Cathedral. Here the old work as hewn with an ax is seen on the side marked *A*, and the new work, after the chisel had superseded the ax and the pointed arch had taken the place of the semicircular one, is shown on the side marked *B*.

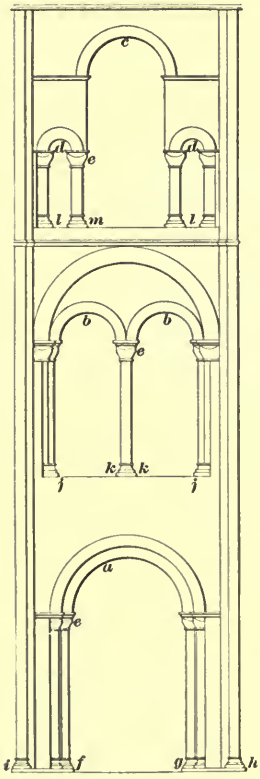


FIG. 56.

120. Fig. 56 shows one bay of the transept of Winchester Cathedral as it was originally erected by its Norman builders in the year 1076. The absolute plainness of the arches, capitals, and columns shows more plainly than words that the desire to produce superficial beauty was entirely subordinated to the endeavor to build permanently and substantially.

No moldings of any kind grace the arches, and no carvings enrich the capitals *c*, but a judicious

grouping of arches at *a*, *b*, *c*, and *d* shows us that they understood the value of graceful proportions and the importance of variety in outline. The arch over *f g* of the nave is as broad as they could safely make it and leave the piers *i f* and *g h* large enough to carry the heavy superstructure and proposed vaulting; but the arched openings *j k* in the *triforium*, or gallery, are divided to give variety,

FIG. 57.

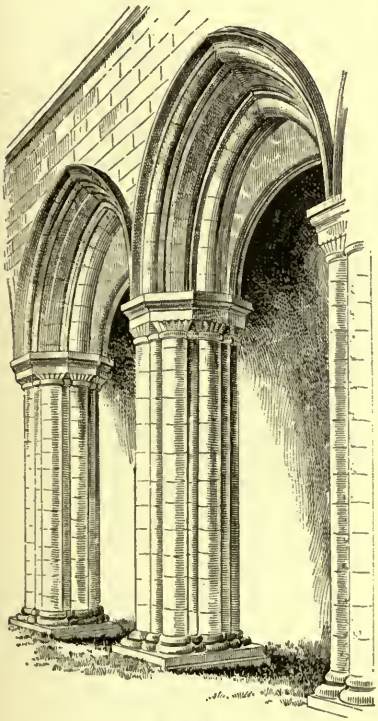


FIG. 58.

and at the same time are sufficiently broad to admit light to the triforium from the nave, while the openings *l* and *m* in the clerestory were comparatively small, as they were high above the roof of the triforium or any other interference and admitted light directly to the nave from the outside of the building. Permanent scientific construction was the governing principle in all this early medieval work, and no attempt was made to embellish its details until after this was assured.

121. Though some of these early Norman arches were molded as explained above, fully as many were left absolutely plain; but, as we approach the early English period, the arches are deeply molded and richly carved. These moldings were not cut before the stone was put in the building, as is done with most modern work, but the stone was corbeled out, one course over another, and

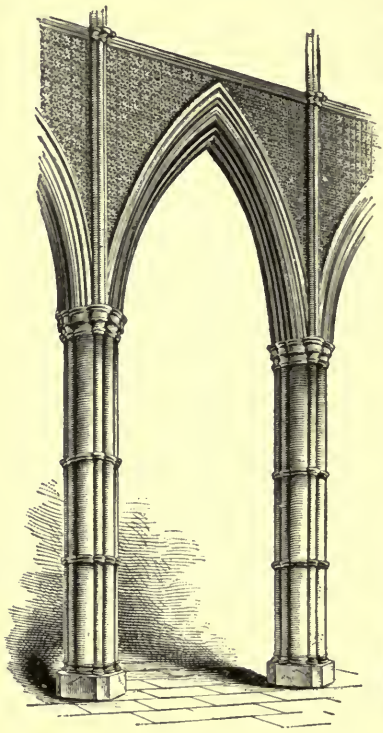


FIG. 59.

the projecting edges were then chamfered and cut into the molded surface as explained under the head of Gothic moldings.

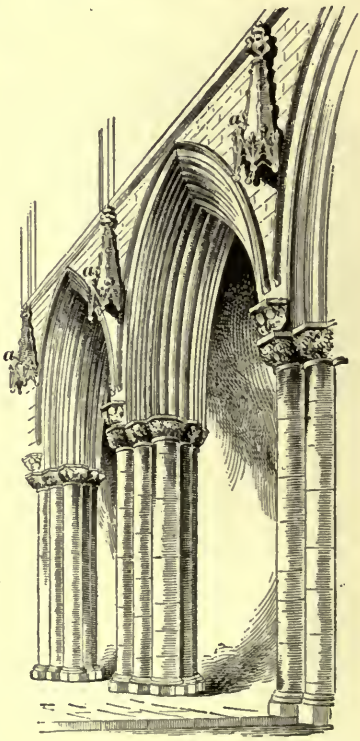


FIG. 60.

122. The late Norman work still retained the massive piers as a support, as shown in Fig. 57, though the molding of the arches gave them an appearance of lightness hitherto unknown; but advancement was rapid, and it was less than

twenty years before the piers began to assume a shape, seen in Fig. 58, that could only end as it did in the multiclustered column of the Perpendicular style.

The arches of the early English period were deeply cut and molded, and were acutely pointed, as seen in the north transept of Westminster Abbey, Fig. 59. During the Decorated period they became still more acutely pointed, and in many instances have projecting canopies on the spandrels between, as shown at *a*, in Fig. 60.

GOTHIC MOLDINGS.

123. The earliest of these Gothic moldings (the Norman), Fig. 61, as shown in the nave of Fountain's Abbey, near Ripon, England, was simply a chamfered corner *a* on two square blocks with a *boltel*, or roll *b*, between. With the introduction of the pointed arch came the pointed boltel *a*, Fig. 62, and it opened the way to an immense number of new forms, the most important of which was the roll and fillet *b*, Fig. 62, as it is the prototype of nearly all subsequent formations. The characteristics of the moldings of this early style are the deep undercut hol-

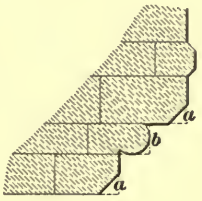


FIG. 61.

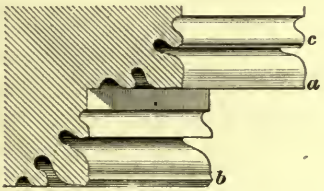


FIG. 62.

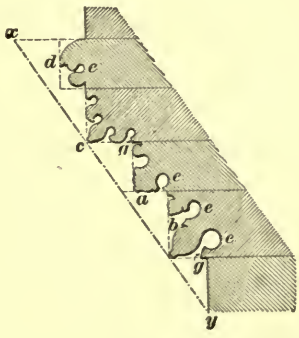


FIG. 63.

lows *e*, Fig. 63, between prominent members. These members include a great variety of pointed and filleted boltels, clustered, isolated, and repeated at certain intervals; a great depth or extent of molded surfaces, as shown by the entire molded surface of Fig. 63; and

the general arrangement in *rectangular faces*, as shown by the dotted outlines of Figs. 61 and 63. The hollows *c*, Fig. 63, give the effect of a series of detailed arches or ribs, rising in succession; they are seldom true circles, but, like the projections, they assume a great number of capricious forms.

124. Early English moldings may be said to be nearly always composed of a combination of the following members: (1) the plain boltel *c*, Fig. 62; (2) the pointed boltel *a*; (3) the roll and fillet *b*; (4) the scroll molding *d*, Fig. 63; and (5) the angular forms consisting of chamfered ridges and intervening projections of an irregular character, as shown at *g*, Fig. 63. The other forms consist of a capricious modification of the roll and fillet.

The roll and triple fillet *a*, Fig. 63, appears late in the English Gothic style, and sometimes only one side is possessed of a fillet, as at *b*, Fig. 63. Three pointed rolls placed together, as at *c*, somewhat in the shape of a fleur de lis, form a combination of very frequent occurrence, with many minor varieties of shape. The scroll *d*, also called edge molding, was used only in the advanced early English and decorated work.

125. The details of decorated moldings are, for the most part, identical with those of the preceding style, with the addition of some new members and several important modifications in grouping. Much greater geometrical precision prevailed in drawing both the hollows and the projecting members during the Decorated period; and the segments of circles, both concave and convex, were much used, with an avoidance of strong contrasts of light and shade, thus imparting a much more pleasing, though less striking, effect. The perfection of molding, as of all architectural detail, is considered by many to have been attained at this period; yet during the Decorated period, rich moldings are of comparatively rare occurrence. Fig. 64 shows a

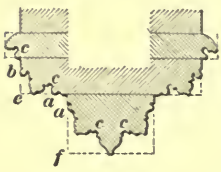


FIG. 64.

group of moldings from the choir of Howden Church, England, and is characteristic of the Decorated period. We get the addition of a few new members, such as the ogee *a*, and double ogee, and we see the plain boltel *b* used very sparingly. The hollows *c* are usually of larger size than those of the early English, and in the Decorated style are used to divide groups of members, while in the previous style they divided individual members.

126. The moldings peculiar to the Perpendicular period are weak in effect, and show a tendency on the part of the builder to save as much trouble as possible. Large and coarse members with little or no fine detail, broad but shallow hollows, as at *a*, Fig. 65, with hard wiry edges, take the place of the soft rounded forms we have just studied. Their general arrangement is on the surface of a large chamfer, instead of on the rectangular recessed surfaces we have observed in the two preceding styles. Compare, for example, the dotted outlines of Figs. 63 and 64, which determine the contour of the stone before the moldings were cut, and we see that in carving their moldings the early English architects followed very closely the rectangular offsets of the stone, and carried their moldings well into the projecting corners, as at *a* and *c*, Fig. 62. The builders of the Decorated period followed the general contour of the stone projections, but avoided the use of the corners of the projecting stones and chamfered them off before starting to cut their moldings, as at *e* and *f*, Fig. 64, while in the Perpendicular period the entire molded surface was chamfered off, and the moldings were cut along the chamfered surface, as in Fig. 65.

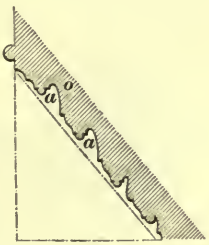


FIG. 65.

PIERS.

127. The general plan of piers and columns supporting the principal arches in Gothic work varies from a plain square or round shaft, in the Norman work, to a complicated

group of small shafts surrounding a central core, during the Perpendicular period. Piers of the earliest period were square, sometimes relieved by half columns, as at *a*, in Fig. 66, and in the early part of the twelfth century they began to assume the form of a Greek cross, as in Fig. 67, with engaged shafts in the angles, as at *a*, as well as on the principal faces *b*. As the style advanced, the smaller columns became detached from the shaft, and in Westminster Abbey we have a round column with four detached columnettes, as shown at *a*, Fig. 68; in a portion of the same structure erected during

FIG. 66.

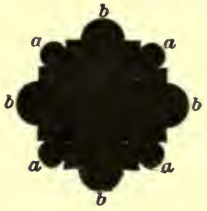


FIG. 67.

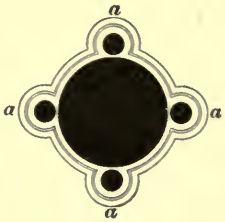


FIG. 68.

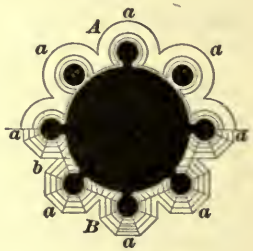


FIG. 69.

the Decorated period, we have also a central pier surrounded by eight small columns *a*, Fig. 69. A peculiarity of this latter example is that the eastern side *A* was completed during the Decorated period, and the western side *B* was erected during the period of the Perpendicular style, when the small columns became again attached to the central pier, indicative of the altered fashion of the day, when the detached piers, once so favorite a feature, were entirely discarded. The rectangular piers built during the Perpendicular period were in detail very similar to Fig. 67, but the solid center was oblong and not square.

CAPITALS.

128. The moldings of capitals and bases are more clearly marked in the various periods of Gothic architecture than are the variations of forms in piers and columns. In

the Norman period, when the shaft was round, the highest and lowest members only were square, the parts immediately next to them being rounded off to suit the shape of the shaft, as shown in Fig. 70. This style of cap is also seen in the transept of Winchester Cathedral, as shown at *e*, Fig. 56. When the sub-arch was introduced, the corners of the capitals were usually cut off. This produced the octagonal form which afterwards gradually merged into the circular, bell-shaped capital, as shown in Fig. 71. When foliage was introduced in early English moldings, it was placed upon the bell of the capital, and but few, if any,

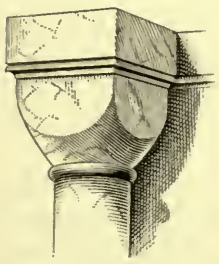


FIG. 70.

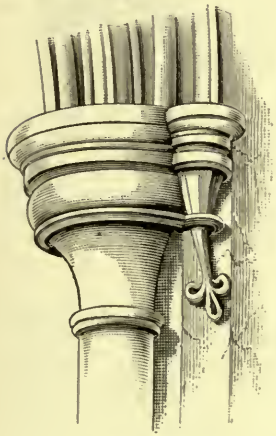


FIG. 71.

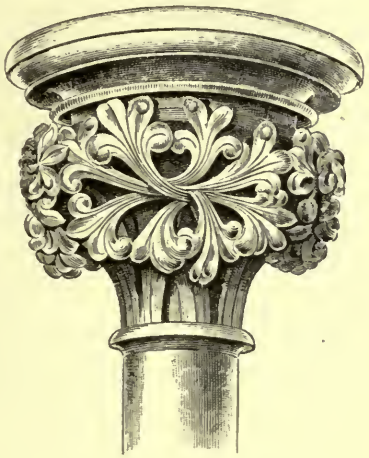


FIG. 72.

moldings beyond the abacus and necking are used with it. The leaves have usually stiff stems, but almost always stand out very boldly, so as to produce a very striking and beautiful effect; they are generally well carved, and often so much undercut that the stalks and more prominent parts are entirely detached, as shown in Fig. 72. In the Decorated period, the molded capitals are generally enriched with the

ball-flower ornament, as observed in *History of Architecture.* The foliated capitals are very richly carved, but are not undercut as much as in the early English style, and the leaves, as shown in Fig. 73, are accurate representations of particular plants and trees, as the oak, maple, ivy, white thorn, etc.

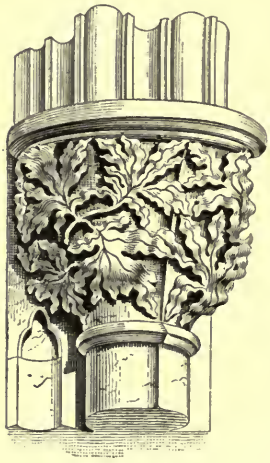


FIG. 73.

Perpendicular capitals were usually plain, though in very large and ornamented buildings they were sometimes enriched with shallow foliage, especially in the early years of the style, when the shafts were circular. The leaves when carved were generally of a very pronounced geometrical shape, such as square or triangular, as shown in Fig. 74, and were not as close an imitation of the natural form and growth as in the Decorated period.

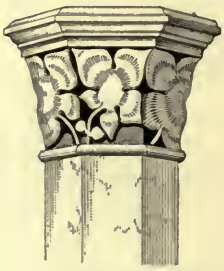


FIG. 74.

BASES.

129. The bases used in the eleventh and twelfth centuries are often a sort of debased imitation of the Attic form used with the classic orders. In the Norman work, the plinth is no more than a square block or step of solid stone, but in the early English work, it is frequently octagonal, and the base moldings—a series of annular rolls, slopes, or hollows—take the form of the column. In Decorated and Perpendicular columns, the plinth is apparently omitted and the base is divided into heights, stages, or tables by gradually spreading courses, each separated from the

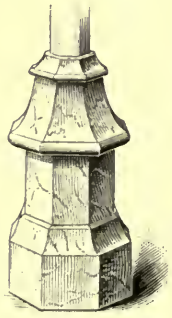


FIG. 75.

next by a plain or by a molded band. The lower part of the base is sometimes octagonal or polygonal, as in Fig. 75. In clustered pillars, with small shafts of different sizes, the bases are often on different levels, and consist of different moldings with only one or two members carried around the pillar, and those are generally on the upper part of the lower plinth.

SPIRES.

130. The nature of the pointed Gothic vault was such as to necessitate very high pointed gables to cover its extremities, and we find this in keeping with all Gothic feeling. As has been observed before, the great contrast between Gothic and Classic work lies principally in the vertical lines of one and the horizontal lines of the other. The spire and tower make their first appearance in Gothic structures, and can be attributed very largely to the desire for long perpendicular lines. There are no set rules for the proportioning of spires, but the general rules illustrated in Fig. 47 nearly always give satisfactory results. If the elevation of a church is placed within the lines of an equilateral triangle so that the gables of the transept touch the sides of the triangle, then the spire may be extended until it reaches the apex of the circumscribed figure. This rule, however, is quite variable; as, when the spire is at the intersection of the nave and the transept, it should be higher, and when it stands at one corner of the structure, it should be lower.

Much in this respect depends upon the general character of the building itself and of the surrounding buildings, and upon the judgment of the architect. The proportions of height to thickness at the base, and the method of springing, are also matters depending almost entirely upon the skill of the architect. If the tower is to be the principal feature of the building, then it should be large, broad, and bold, like the dome of St. Paul's Cathedral, Fig. 113, *History of Architecture;* but if it is simply to be an adjunct to emphasize a certain tame corner in the design, or to call

the eye away from a lot of monotonous detail, then it should not be excessively prominent, as is the Victoria Tower of the Houses of Parliament, in London, Fig. 130, *History of Architecture;* nor should it be dwarfed and insignificant, as is the central tower on the same building.

131. The construction of the tower and spire, however, requires very close study and attention. A bell tower erected to contain a single bell or a set of chimes should have a thoroughly solid foundation. It is preferable that such a tower should not contain a clock, as the vibration from the bells affects the mechanism.

The floors in a bell tower should always be built on offsets on the inside of the walls; as, if the timbers are let into the walls, they will rack and crack the joints clear through the masonry. Heavy bells should never be hung upon a cross-beam resting on the walls, but should be enclosed in a trussed cage, in order that the vibration may be largely taken up by the timberwork before it is transmitted to the walls. Where chimes are hung, they should be placed on one level in preference to two tiers, as the sound blends much better when they are close together.

Spires and towers should always be designed with a slight curve of entasis, for the same reason that the classic columns are so drawn. Towers should always have a taper or diminution in their lines, and if there are windows or other openings, the larger ones should be above the smaller ones —an arrangement which gives a feeling of lightness to the upper part of the structure and is pleasing to the eye.

ARCHITECTURAL DESIGN.

(CONTINUED.)

NATURE AND FUNCTION OF ORNAMENT.

INTRODUCTION.

1. The term **ornament,** in its limited sense, includes such elements of decoration as are adapted or developed from natural forms and foliage. These differ from geometrical elements, inasmuch as they are organic, possess branches, leaves, blossoms, etc., while the latter are inorganic, and, for their expression, depend entirely upon their geometrical form and relative arrangement. When simply drawn on paper, and not in any way executed as an architectural feature, an element of decoration is considered, in the abstract, simply as an ornament, and only when such an ornament is applied to beautify an object does it become, in an architectural sense, an element of decoration.

2. The term **decoration** is applied to the process and result of applying the various elements to beautify objects or surfaces. The elements of decoration consist of geometrical lines, natural foliage, artificial objects, animals, and the human figure. These may be considered as ingredients, which are mixed and applied in various proportions, according to certain acknowledged rules, termed **principles.**

3. The *principles* of decoration, as separated from the elements which are used to make up the design, depend upon certain rules of architectural proportion. This is illustrated in the subdivision of a wall surface into three horizontal bands, the dado, the wall, and the frieze; in the relation of a pedestal, column, and entablature of an architectural order. This general division may exist only in the placing of horizontal lines, and each separate part may be again subdivided or ornamented to constitute a theme of decoration. Subdivisions by means of lines are geometrical elements. The decoration of the subdivisions may be accomplished by means of natural foliage, such as leaves or running vines; by artificial objects, such as the hieroglyphics of the Egyptians; or by animals, and the human figure, as in the Gothic and Renaissance designs. But in each case the subdivisions must be proportioned to the general divisions, according to certain established rules, explained hereafter.

Whatever the theme of decoration may be, whether it be the invention of an original form, or only the arbitrary adaptation of some familiar idea, two conditions will always be found to exist: (1) The decoration produced by an arrangement and joining of dots and lines, or by the combination and division of geometrical figures in accordance with the laws of rhythm, regularity, and symmetry; and (2) the decorative *effect* arising from the attempt to represent the objects of the external world. Nearest at hand for imitation is organic nature, with the plants, animals, and human form; but inorganic nature also offers models, as the forms of crystallization, snowflakes—all phenomena of nature, such as clouds, waves, etc.; and rich sources are opened up by artificial objects, which are fashioned by man himself.

It is obvious that all kinds of elements may be combined. Geometrical may be united with natural forms, and details taken from nature may be combined with creatures of the human imagination, to form eccentricities which are not existent in nature, but which man has always delighted in adopting to represent some supernatural power. Among these may be cited the sphinx, the centaur, and the mermaid

of ancient art, while human and animal bodies with plant-like and foliated terminations are prevalent in many details of Renaissance design.

4. Decoration, as applied to architecture, consists, first, of the ornamentation of the structural features of the building, of the variation in color or proportion of different surfaces which are adjacent, and in the application of familiar symbols or objects, to convey a definite historical or religious idea to the mind. All architectural decoration is influenced by its historical period, by its geographical surroundings, and by the conditions of the religion and the intellect of the people by whom it is applied.

Historically, the decoration of no two periods is exactly alike. Geographically, the scheme of ornament of no two countries (save in the things of their mutual local surroundings) is alike; and inasmuch as nearly all decoration makes use of symbolic forms, the variations of religion will effect a corresponding variation of the symbols used. These, combined with the other influences, give us an unlimited field for combinations of ornamental design, which, though practised for centuries, has not yet exhausted originality.

ARRANGEMENT OF FORM AND COLOR.

5. All decorative arts, whether carving, wall painting, or ceramics, arise from, and should be attendant upon, architecture, as architecture is the material expression of the wants, facilities, and sentiments of the age in which it is created. And also, as in architecture, all products of the decorative arts should possess fitness, proportion, and harmony, in order that the result may express what we term *repose*. Beauty results from that repose which the mind feels, when the eye, the intellect, and the affections are satisfied and free from any sense of want. Construction may be decorated, as has already been explained, but decoration should never be purposely constructed. It, therefore,

may be stated that, as that which is beautiful is true, conversely, that which is true must be beautiful; and upon this axiom depends all the beauty of ornament in architecture.

6. In the decoration of a surface, the general form is first cared for, and subdivided and ornamented by general lines. The interstices may then be filled with ornament, or may themselves be again subdivided, if desirable, and enriched for closer observation. But all ornamentation, no matter how minutely carried out, should be based upon a geometrical system of construction, as a true proportion will be found to exist between all the members so based. In every perfect work of architecture, and throughout the decorative arts, every assemblage of forms should be arranged in certain definite proportions, each and every member of which should be a multiple of some governing unit.

In surface decoration, a rule to be observed in all work is that all lines should flow from a parent stem, so that every ornament, no matter how distant, can be traced back through its branch to its root; that all junctions of curved lines with other curved lines, or of curved lines with straight lines, should be made so that, at the junction, the lines will be tangent to each other. Flowers and other natural objects should not be used as ornaments in their natural forms, but should be conventionalized or reduced to geometrical principles, which convey the idea of what they represent without purporting to be an accurate likeness of the original.

7. **Color** may be used to assist in the development of a form, or idea, or to distinguish objects, or parts of objects, one from another; or color may be used to assist light and shade, helping the undulations of form by the proper distribution of several different tints; but color should never be used unless the exigencies of the case positively require it, and all design should depend for its intrinsic beauty upon its form and proportion, which may be enhanced by combinations of color, but should never depend entirely upon the color itself.

EGYPTIAN ORNAMENT.

8. The peculiarity of Egyptian architecture over all other styles is that the more ancient the monument, the nearer perfection is the art. Monuments erected two thousand years before the Christian era are built of stones taken from the ruins of still more ancient and more perfect buildings. Hence, we are not only compelled to study Egyptian art during the period of its decline, but are equally compelled to accept the art of that period as an original style, as we have no record of the existence of any earlier nation from whom they could have borrowed ideas.

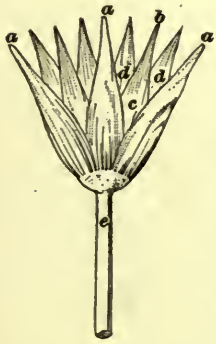


FIG. 1.

FIG. 2.

In Egyptian art we have no traces of infancy or of foreign influence, and we must, therefore, believe that the Egyptian artists drew their inspirations direct from nature. In Egyptian ornament the types are few but natural, and the representation is but slightly removed from the type. The later we descend in art, the more we find the original types receded from, until it is difficult in many cases to discover the original idea from which the ornament, by successive mental efforts, has been developed.

9. The lotus, Fig. 1, and the papyrus, Fig. 2, growing on the banks of the Nile, symbolic of physical and mental food; the feathers of rare birds, Fig. 3, carried or held before the king, emblematic of sovereignty; and the palm branch, with the twisted cord made from its stems—are the few types which form the foundation of the immense variety of ornament with which the Egyptians decorated the temples of their gods, the palaces of their kings, the covering of their persons, and their articles of luxury, as well as those articles of more modest daily use, from the wooden spoon which fed

them in infancy, to the mournful boat which carried their embalmed bodies across the Nile to their final resting places in the Valley of the Dead.

Following these types as they did, in a manner so nearly allied to the natural form, they could hardly fail to observe

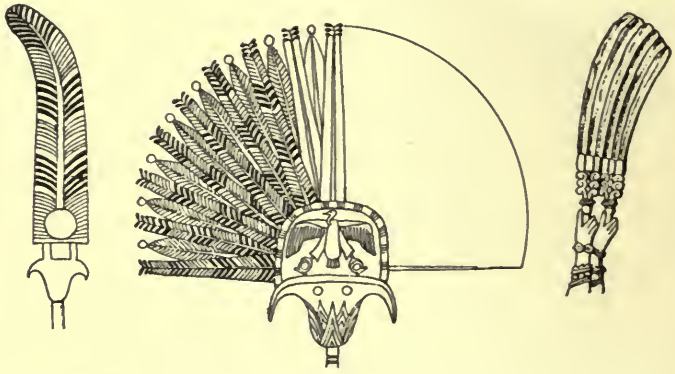


FIG. 3.

the same laws which the works of nature ever display, and we therefore find that Egyptian ornament, no matter how conventionalized, is always true. The Egyptian artist never violated a natural principle, nor, on the other hand, did he destroy the consistency of the representative by a too servile imitation of the type.

A lotus carved in stone, forming the graceful termination of a column, or painted on the walls as an offering to the gods, was never such a one as might be plucked, but was an architectural representation of it.

10. Egyptian ornament is of three kinds: that which is constructive, or forms a part of the monument itself; that which is representative, but is at the same time conventionally rendered; and that which is simply decorated. In each case the ornament is always symbolic, and the few types on which it was founded were but slightly changed during the entire period of Egyptian civilization.

Of the constructive ornament are the decorations of the columns and crowning members of the walls. The column

base was frequently molded to represent the root, the shaft was reeded in imitation of the stalk, and the capital was carved in the form of a full-blown lotus flower. All this was symbolic, as the lotus flower meant much to the Eygptian.

11. The lotus blossom was very similar to the ordinary pond lily, except that it grew on a stiff stalk and its petals were tipped with deep purple. It bloomed in abundance on the banks of the Nile, and was associated with all the blessings the Egyptian derived from that fertile river and plain. Hence, the columns of his temples were nearly always fashioned on the symbol of the lotus plant, representative of the abundance of Providence.

The cornices of the temples were usually decorated with ornaments derived from a combination of feathers, which were an emblem of sovereignty, while in the center of the cornice and over each entrance was the emblem of divinity and immortality, the winged globe (Fig. 4).

12. The winged globe is one of the most conspicuous details of Egyptian ornament. It varies slightly in detail, according to the purpose and place where it is used, but consists essentially of a globe or disk, on each side of which spreads a hawk's wing, as shown in Fig. 4. The coiled asp

FIG. 4.

as emblematic of royalty is sometimes added to the disk, but not always. There is no other architectural detail so characteristic of its style and nation as is the winged globe in ancient Egyptian art.

Carved over their doors, painted on their walls, and woven into their fabrics, the Egyptians portrayed this emblem of their sincerity wherever opportunity arose.

13. The second kind of Egyptian ornament results from the conventional representation of actual things on the walls of the temples and tombs. These representations, whether indicative of an offering to the gods, or illustrative of a utensil of daily use, are not portrayed as a reality, but are conventionalized to an architectural ideal. Each object is a hieroglyphical record of a fact, and at the same time an architectural decoration. This representative ornament was sometimes carved in the surface of the walls, and sometimes simply painted, while in other cases it was carved and painted also. Fig. 5 shows a somewhat conventionalized bunch of papyrus and lotus blossoms, as these types were frequently arranged for wall decoration, as seen in the tombs and temples. The symmetry each side of the center line is characteristic of this style of Egyptian ornament, as is also the rich coloring, which, however, these illustrations do not show. Observe the straight, stiff stem, the trumpet-shaped blossom, the sharp-pointed petals of the calyx—all characteristics of the growing plant, which are emphasized in this section of ornament in order to secure absolute conventionalism. Fig. 6 shows another, but simpler, rendering of the papyrus plant, which is identical in character with Fig. 5, but devoid of a single line unnecessary to its conventional portrayal. The straight stem, the trumpet blossom, and the sharp petals are all here, but are rendered in a monotint as a purely hieroglyphic inscription, with the omission of every detail not necessary to the conveyance of an idea. A single glance at Fig. 6 is sufficient to impart the information that it portrays a papyrus plant—more than that it does not express, nor is intended to do so.

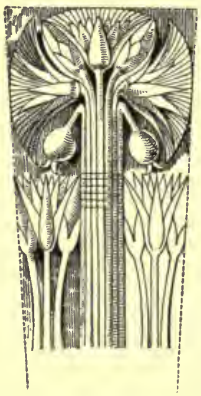


FIG. 5.

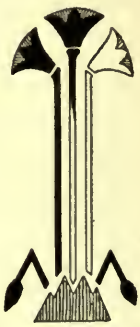


FIG. 6.

14. The third kind of Egyptian ornament, that which is purely decorative, is found mostly in paintings on tombs, dresses, utensils, and *sarcophagi*, or stone coffins.

The architecture of the Egyptians is thoroughly *polychromic*, or many colored—they painted everything. They used only *flat tints*, however, or those without shading, and yet found no difficulty in conveying to the mind the identity of the object they desired to represent, without the aid of either shade or shadow. A fair idea of the conventionality of their forms may be obtained by a comparison of Figs. 1 and 7. Fig. 1 is a sketch of the lotus blossom as it appears in nature. The outside leaves *a* are a deep green in color, while the petals *b* are a rich purple at the tips, but shade off to pure white at *d*, except the outside row, which shades to orange at *c*, while the stem *e* is a light green. In Fig. 7 is the conventional representative of the lotus in Egyptian painting. In this case the outside leaves of the calyx *a* are a dark green, and the next row of leaves *b* are green also, but of a lighter shade, while the petals *c* are painted red, and the background *d* is a deep yellow. At a distance from the eye, the red and yellow blend and form an orange tint, suggestive of the color of the heart of the flower. The colors used by the Egyptians were principally red, blue, and yellow, with black and white to define and give distinctiveness to the various colors. Green was frequently,

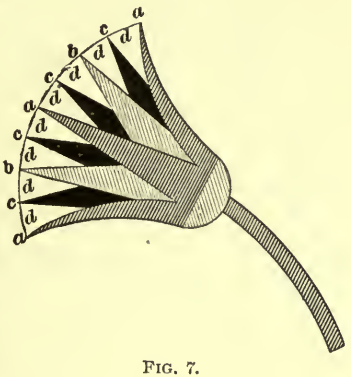


FIG. 7.

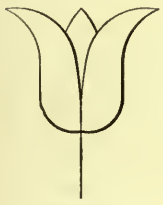


FIG. 8.

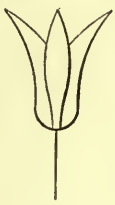


FIG. 9.

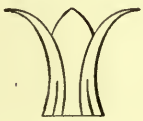


FIG. 10.

but not always, used as a local color, such as for the leaves of plants, etc., and as many representations of the lotus blossom are painted with blue leaves as with green.

When the lotus was drawn only in outline or painted in *monochrome*, or one color, we find its form still more conventionalized into such shapes as Figs. 8, 9, and 10, and these latter forms undoubtedly had very considerable influence on later art forms, as will be observed when we reach that period.

GREEK ORNAMENT.

15. Egyptian ornament, we have seen, was derived from natural inspiration. It was founded on a few simple types, which remained unchanged during the whole course of Egyptian civilization, except in the greater or lesser perfection of the execution. The Assyrian style was borrowed from the art of Egypt, during the decline, which decline they carried still further, but the Greek art, on the contrary, though it was borrowed partly from the Egyptian and partly from the Assyrian, was the development of an old idea in a new direction; unrestrained by religious laws, as both the Egyptian and the Assyrian appear to have been, Greek art rose rapidly to a state of perfection from which it was able to give forth the elements of future greatness to other styles. It carried the perfection of pure form to a point which has never since been excelled, and from the abundant remains we have of Greek ornament, we must believe that refined taste was duly appreciated, and that the land was overflowing with artists whose hands and minds were so trained as to enable them to execute these beautiful ornaments with unerring truth.

Greek ornament lacks, however, one of the greatest charms which should always accompany ornament, namely, *symbolism*. It is purely decorative, never representative, and in some cases not strictly constructive. Like the Egyptian style, the types are few, but the drawing is so conventional that it is often difficult to recognize the original type.

In the well known painted honeysuckle ornament, shown in Fig. 11, it is difficult to recognize any attempt at imitation, but rather an appreciation of the principle on which the flower grows. And in the carved ornament shown in Fig. 12, also from the honeysuckle, how faint is the resemblance.

FIG. 11.

But it is evident that the Greeks were close observers of nature, and though they did not copy or attempt to imitate, they worked on the principles which governed the growth of the plants they conventionalized. There are three great unalterable laws which we find everywhere in nature; these

FIG. 12.

are: *radiation from the parent stem, proportionate distribution of the areas of the branches and leaves, and the tangential curvature of the lines.* These laws were invariably obeyed by the Greek artists, and it is the unerring perfection with which they were realized by the Grecian that renders the reproduction of the Greek system of ornament so rarely crowned with success at the present day.

A characteristic feature of Greek ornament continued by the Romans, but abandoned during the Byzantine period, is that of the various parts of a scroll growing out of one another in a continuous line, as shown in the ornament from the choragic monument of Lysicrates, Fig. 13. In the

Byzantine, Moresque, and early Gothic styles, the flowers flow off on either side of a continuous stem, showing how a slight change in any generally received principle is sufficient to generate an entirely new order of forms and ideas. Roman ornament appears to be constantly struggling against

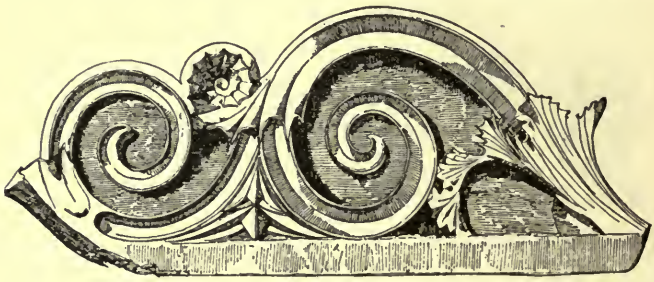


FIG. 13.

this apparently fixed law. Fig. 25 is an example which may be taken as typical of the scheme of all Roman ornament, which scarcely ever advanced beyond the arrangement of a volute, springing from a stem, which fitted into another stem and encircled a flower. The change which took place during the Byzantine period in discarding this law, is as important in its results to the development of ornament as was the substitution of the arch by the Romans for the straight architrave of the Greeks, or the introduction of the pointed arch in the architecture of the middle ages, as we shall learn as we progress.

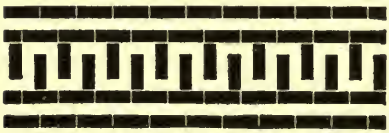


FIG. 14.

FIG. 15.

16. The simplest and most ancient form of ornament we find in Greece is the *fret*. By what race it was first introduced is not known. It existed in its simpler form in the earliest epochs of Egyptian art, and is probably derived

from an arrangement of differently colored bricks, as Figs. 14 and 15 would suggest. In early Egyptian hieroglyphics we find two characters, Fig. 16, which are component parts of frets, and which, when combined, as in Figs. 17, 18, and 19, comprise the earliest forms we are familiar with in fret ornament. However, whether the fret was introduced by the early Egyptians or not, it is practically certain that the Greeks adopted it from Egypt; and, like the Doric column, which they borrowed from the same source, they improved on the original and brought it to the state of perfection found in

Fig. 16.

Fig. 17.

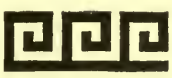


Fig. 18.

Fig. 19.

all Greek art. The Greek fret differs from all its predecessors in the fact that the line of the fret is always continuous, and is not broken, as are the Egyptian and Arabic examples, while the lines of the fret and the spaces between them form, in most cases, a similar pattern.

17. On the plate entitled, Vases and Borders, *Ornamental Drawing*, we find the perfected Greek fret in Fig. 9, while Fig. 10 shows a later and more intricate application of the same idea, known as a *meander*, on account of its intricate interlacing straps or ribbonwork. From the meander to the *guilloche*, Fig. 11, is but a step in design, and the *guilloche*, in its various forms, is the ornament with which the *torus molding* of the Grecian bases is most frequently enriched.

Fig. 20 shows a complicated form of the guilloche carved on the torus of the base of a pilaster in the Temple of Nemesis, at Rhamnus, and is here suggestive of a tightly braided strap.

On the same base is seen a bead molding *c*, cut into the globular and disk forms mentioned under the description of classic moldings. On the plate entitled, Conventionalized Leaves, *Ornamental Drawing*, we have, in Fig. 6, a waterleaf ornament used in various forms to decorate the cyma reversa, as is also seen at *a* in Fig. 20, with the bead *b* again adjacent to it. This ornament cannot well be made to miter neatly on the angle, hence we find the corners finished with a form of either the honeysuckle or the lotus-flower ornament, as seen at *a*.

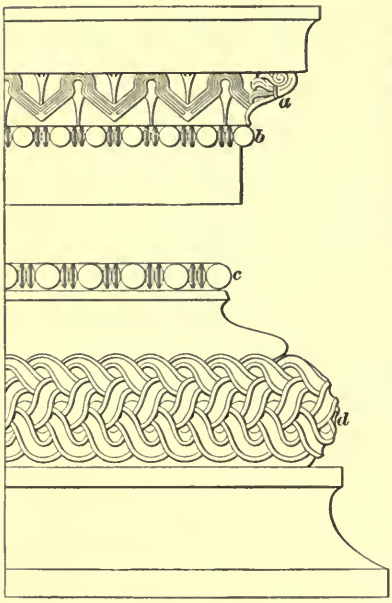


FIG. 20.

The honeysuckle vine formed one of the favorite objects of ornament and decorative design with the Greeks, and they invented a great variety of ornamental figures which were based on conventionalized forms of the honeysuckle blossom. What the lotus blossom was to the Egyptians, this honeysuckle flower seems to have been to the Greeks, though in many instances they used the lotus blossom and also its leaves, especially in painted work.

18. In the ornamental forms which they borrowed from the vegetable kingdom, the Greeks were as simple and homely in their tastes as they were in the general character of their architecture. Instead of embellishing their structures with carved and painted representations of the more elaborate and cultivated plants, we find beautiful ornaments which had for their prototypes the running vine of the pumpkin and squash, and leaves of parsley, celery, etc. On

the plate entitled, Conventionalized Leaves, *Ornamental Drawing*, we have, in Fig. 3, conventionalized forms of the leaves of these latter plants, while Figs. 1 and 2 are geometrical forms of the lotus flower.

Fig. 1 of plate entitled, Applied Ornament, *Ornamental Drawing*, is a late Grecian palmette, or fan ornament, of conventionalized honeysuckle, and shows the form in which this flower was frequently represented. As said before, the Greeks made use largely of the lotus flower in their decorations, and indirectly it was used in nearly every point of their ornament. Many, if not most, of the Greek art forms are traceable to Egypt, and a large majority of Egyptian art forms are traceable to the lotus flower or lotus bud. The conventionalized forms of lotus illustrated in Figs. 8, 9, and 10 were often used as a border or frieze decoration, and the form shown in Fig. 10, when used as a painted border, Fig. 21, is strongly suggestive of the possible prototype of the egg-and-dart ornament with which the ovolo was generally enriched. The cyma recta or the ovolo, when they formed the uppermost or crown molding of the cornice of the building, were usually decorated with the lotus and honeysuckle ornament carved in low relief, as shown in Fig. 12, or were painted in the quieter colors, as illustrated in Fig. 22.

FIG. 21.

19. *Polychromy* is the term applied to the ornamentation of sculptured and architectural works by means of colors. In ancient buildings these colors were made to cover both flat surfaces and architectural details, while in statues or individual portions of the human figure, and drapery, and in other products of plastic art, separate features of a sculptured ornament were colored in a manner characteristic of the subject.

Egyptian polychromy, on columns, bases, capitals, entablatures, wall spaces, and, in fact, on almost everything of an architectural character, expressed itself in a series of highly

colored designs in low relief, consisting mostly of figures and hieroglyphics, and often of purely decorative ornament.

In Greek architecture a complete system of color had been developed at an early period, particularly as applied to Doric temples, upon numerous remains of which, traces of this coloring are still distinguishable.

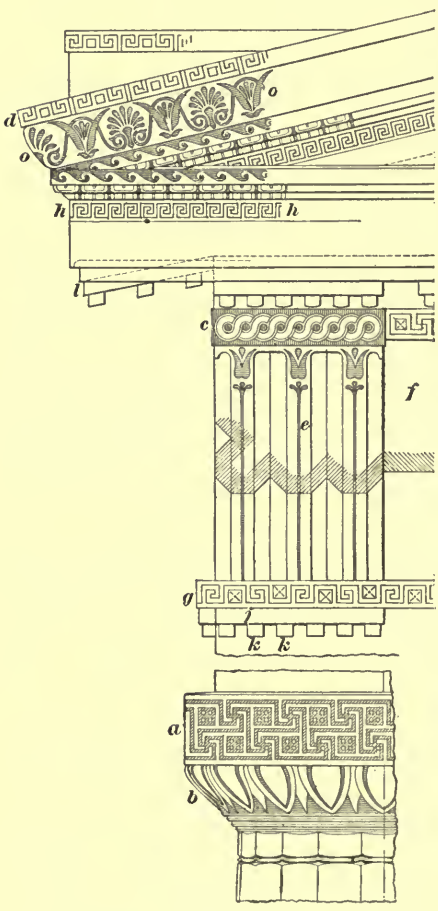


FIG. 22.

The principal use of color in architecture is to bring out decoration. Surfaces may be relieved by a rich play of color without actual relief, and ideas may with facility be expressed by colors, when the object they embellish calls for the widest possible range of imagination and fancy. Still, color has its own province, and to a certain extent its own series of forms, and must, therefore, be treated in its own manner. A harmonious interplay of colors, with correct proportion in the distribution of each, is characteristic of a fine work of art. In truly artistic periods, color has never been used to produce artificial shadows or to bring out artificial depths and reliefs; nor has it in any way been employed as a makeshift for them.

Figs. 22 and 23 show examples of Greek painted ornament in which the fret and the lotus and honeysuckle ornament are both prominent. Red, yellow, blue, and green were the principal colors used by the Greeks in these decorations, but they were so toned down and softened that the glare and harshness of such brilliant colors were blended into one delightful monotint, as one viewed their structures from a distance. Fig. 22 shows a portion of the capital, entablature, and pediment of the Grecian-Doric order, with the characteristic polychromic ornamentation. The fretwork on the abacus at *a* was usually executed in a dark red or black, while the groundwork was pale yellow or orange. The egg-and-dart ornament on the echinus of the capital *b* was generally painted in red on a dark-blue ground. The triglyphs *c* were nearly always blue, and any ornament *e* on them was executed in red. The metopes *f* were generally red, and the sculptured figures with which the metopes were ornamented were painted in tints which represented the color and texture of their garments.

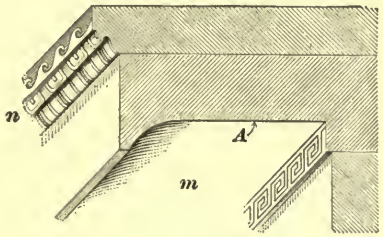


FIG. 23.

The fret drawn on the tænia, or fillet *g*, and those on the corona and epitithedas, as at *h* and *d*, were usually executed in gold, though occasionally in red. The regulæ *j* were blue with red drops, or guttæ *k*, as were also the mutules *l*, but the soffit of the corona *m*, shown in Fig. 23, was red. The small moldings *n* forming the finish to the corona were generally painted in light colors, such as red and blue, with spaces of white alternating between. The honeysuckle or lotus ornament, usually found on the cyma recta, or ovolo *o*, Fig. 22, when either was the top molding of the pediment, was carefully outlined in gold, and was always drawn very lightly and delicately when used to embellish this top member of the entablature.

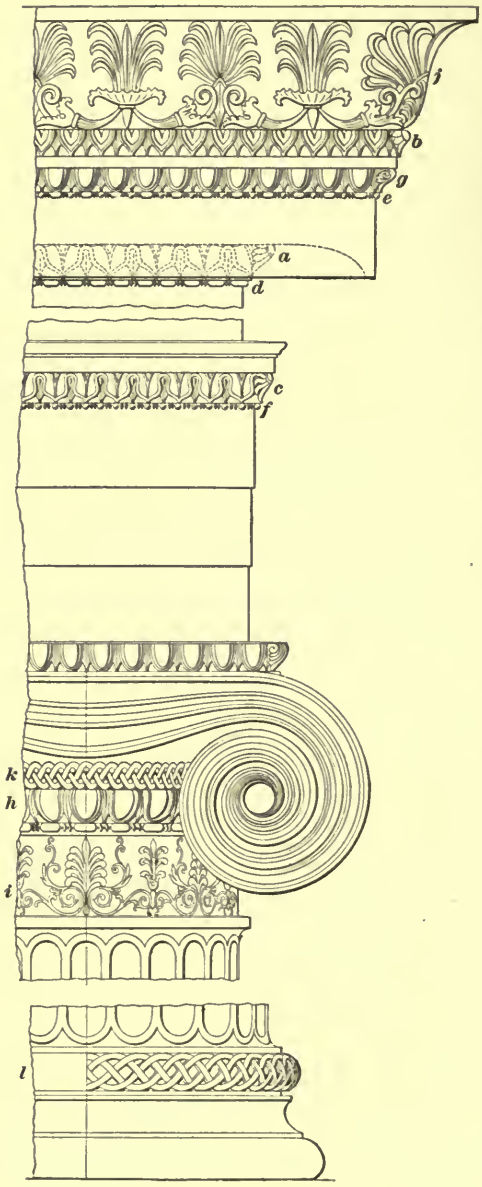


FIG. 24.

20. In Fig. 24 are shown examples of *raised*, or relieved ornament, as seen in the details of the Temple of Athena Polias, in the Erechtheum at Athens. The enrichment on the cyma recta *j* is the lotus-flower ornament, and is carved in very low relief; that is, it is so cut as to be raised but slightly above the surface of the molding, and is not sunk into it as was customary with the Egyptians. As we examine later monuments of Grecian architecture, we find the relief of the carvings increasing, until, when we reach the Greco-Roman period, the stems and stalks are in many instances so undercut as to be almost clear of the molding.

The waterleaf carving on the cyma reversa occurs three times in this

entablature, and is of varied form, according to its location. Up under the corona at *a*, where the shadow is deep and dark, the waterleaf is cut broad and bold, but immediately below the cyma at *b*, and above the upper facia at *c*, the lines of the leaf are drawn longer and narrower, so that the moldings appear in more delicacy of outline where the full strength of the light strikes it. The same thing may be said of the bead moldings under the corona at *d* and under each of the two lower cymæ reversæ at *e* and *f*. The one in the shadow of the corona, as at *d*, is cut into long beads, while the one above the corona, as at *e*, is divided into much more minute divisions; and the one on the top of the upper facia, as at *f*, being in the strongest light of all, is turned into forms where the *bead* is simply a tiny sphere between two pairs of disks of the same diameter. The egg-and-dart ornament of the ovolo occurs here above the corona of the entablature at *g* and under the guilloche and volutes of the capital at *h*, the only difference in these two examples being that the one above the corona is carved upon a straight ovolo extending along the top of the corona, while the other is carved in the circular echinus surrounding the top of the column. The honeysuckle ornament cut on the neck of the column *i* is in low relief, the same as that upon the crown molding *j*. The guilloche *k* immediately under the lines of the volute is carved as a thin strap, loosely braided, around the top of the column, and the same ornament is cut on *l*, the upper torus of the base.

ROMAN ORNAMENT.

21. The most characteristic expression of Roman art is to be found in their palaces, baths, theaters, aqueducts, and other works of public utility, and not in their temple architecture, which, being only a monumental evidence of a religion borrowed from the Greeks, in which the Romans had little faith, exhibits a corresponding want of earnestness. In the Greek temple it is everywhere apparent that the struggle

was to arrive at a perfection worthy of the gods. In the Roman temple the aim was self-glorification.

From the ground line to the crown molding every part is overloaded with ornament, tending rather to dazzle the eye by the quantity than to excite the admiration by the quality of the work. The Greek temples, when painted, were ornamented as much as those of the Romans, but with far different results, as the ornament was so arranged that it threw a colored bloom over the whole edifice and in no way disturbed the exquisitely designed surfaces which received it.

The Romans failed to appreciate the general proportions of the structure and the contours of the molded surfaces, which in their structures were entirely lost by the elaborate carving on them of rich surface ornament—ornament that did not appear to grow naturally from the surface of the molding, but was applied to it. This may be most clearly illustrated by the acanthus leaves under the modillions and around the bell of the capital of the Corinthian column. The leaves are not bound together by the necking at the top of the shaft, but rest on top of it. In contrast to this is the Egyptian capital, where the stems of the flowers around the bell are continued through the necking, thus expressing at the same time both beauty and truth. In the use of the acanthus leaf, the Romans exhibited but little art; they inherited it from the Greeks, beautifully conventionalized, but they exaggerated the surface decoration, though they approached much nearer the natural outline. The Greeks

FIG. 25.

confined themselves to the principle of the foliation, and bestowed the greatest care on the delicate undulations of its surfaces. Fig. 25, as said before, is typical of all Roman ornament, a scroll growing out of a scroll encircling a flower. In Greek ornament the scrolls grow out of each other in a similar way, but they are much more delicate and refined at the point of junction. The acanthus leaf is also seen in side elevation in Greek work, but very rarely in Roman.

22. The purely Roman method of using the acanthus is seen in the Corinthian capitals (see plate entitled, Corinthian Details, *Advanced Architectural Drawing*), where the leaves are flattened out and lay one over the other. The amount of design that can be obtained by working out this principle of leaf within leaf, and leaf over leaf, is very limited, and it was not until the principle of one leaf growing out of another in a continuous line was abandoned for the adoption of a continuous stem throwing out ornaments on either side, that pure conventional ornament received any advancement. The earliest symptoms of the change are found in the Church of Hagia Sophia, at Constantinople, and the first examples of the complete change mark the dawn of the Byzantine style.

23. The decoration and enrichment of Roman moldings, like all the rest of their ornament, was excessive and inartistic. The Greeks decorated one or two of the moldings of their bases with a guilloche and a bead, while the Roman idea of enrichment was to cover the entire base, and even a portion of the shaft, with applied ornament. The torus was usually decorated with laurel leaves or oak leaves, Fig. 26, or in some cases with scrolls of acanthus, Fig. 27. The ovolo, instead of being simply carved with an egg-and-dart

FIG. 26.

ornament, is lavishly decorated with a leaf-and-tongue ornament, or with the egg-and-leaf ornament as seen in the Temple of Jupiter Tonans, at Rome. The cyma reversa, which the Greeks enriched with the simple waterleaf ornament, was complicated by the Romans into the form shown in Fig. 28. The Roman cyma recta was decorated with a complicated variety of ornaments of which the acanthus leaf predominated. The frieze, especially of the Corinthian order, was frequently carved or painted to represent scenes in the lives of the gods, or from other mythological tales, as in the Forum of Nerva, at Rome.

FIG. 27.

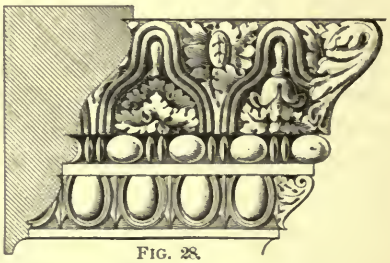


FIG. 28.

BYZANTINE ORNAMENT.

24. When Constantine the Great transferred the seat of his empire from Rome to Byzantium, in the year 330 A. D., he found himself under the necessity of employing oriental workmen and artists to carry out his ideas and erect his buildings. There can be little doubt that each of the surrounding nations aided in giving its impress to the newly forming style, according to the civilization each possessed and its capacity for art advancement, until the motley mass finally became fused into one systematic whole, during the long and artistically successful reign of Justinian I, from 518 to 565 A. D. In the result can be seen the influence exercised by the great Roman temples and theaters, built in Asia Minor during the rule of the Cæsars. In these we see the

tendency to elliptical outlines, acute-pointed leaves, and thin continuous foliage, without the springing base and flower which characterize Byzantine ornament.

FIG. 29.

These buildings of Asia Minor having been erected under the influences of Syrian and Persian art, as well as that of other countries, we see that their effect on the birth of the Byzantine style must have been to give it a certain amount of oriental tinge according to the state of religion, art, and civilization, in the countries where it was received.

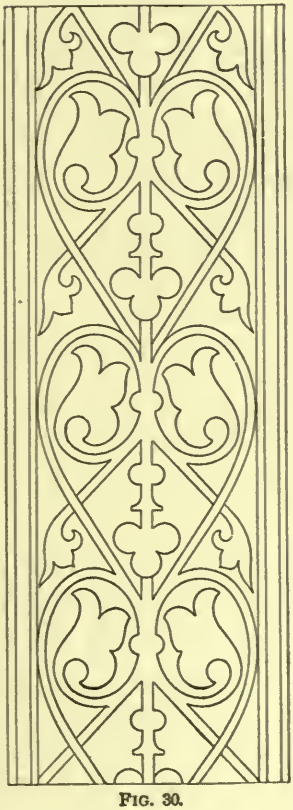


FIG. 30.

Pure Byzantine ornament is distinguished by broad-toothed and acute-pointed leaves, which in

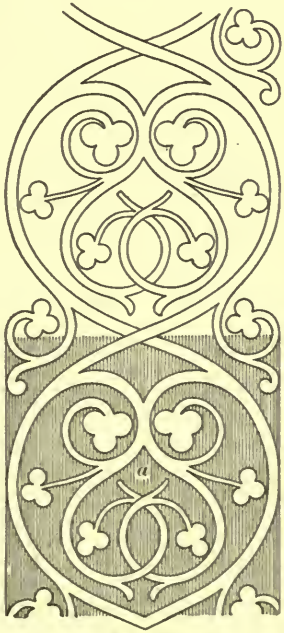


FIG. 31.

sculpture have the edges beveled and are deeply channeled throughout, and have deeply-cut incisions at the loops of the leaves as shown at *a*, Fig. 29, which is a carved acanthus leaf from the Church of Hagia Sophia at Constantinople.

The running foliage is generally thin and continuous, as shown in Figs. 30 and 31, and the background *a*, whether in mosaic or painted work, is almost universally gold. Thin, interlaced patterns were preferred to geometrical designs, and the introduction of animal figures was very limited, especially in sculpture. In painted work the human figure is sometimes introduced, but is confined almost entirely to religious subjects, and is rendered in a stiff, conventional style, with little variety or feeling. In fact, sculpture in Byzantine art is of secondary importance.

ROMANESQUE ORNAMENT.

25. Romanesque ornament differs from Byzantine in relying mainly on sculpture for effect. It is rich in light and shade, deep cuttings, massive projections, and a great intermixture of figure subjects with foliage and conventional ornament. The place filled by mosaic work in Byzantine art is occupied by painted work in the Romanesque, and in the polychromic ornament animals are as freely introduced as in the sculpture. The backgrounds are no longer exclusively of gold, but are mostly blue, red, or green. In other respects, making some allowance for local influences and religious differences, Romanesque ornament retains much of the Byzantine character, especially in stained glass-work, and this character is continued to the middle, and in some cases to the close, of the thirteenth century. There is no record of the number of Byzantine workmen and artists who were employed throughout Europe, but there can be but little doubt that the character of the Byzantine school of ornament is very strongly impressed on all the earlier

works of central, and even western, Europe, which are generally termed Romanesque.

There is, however, one style of ornament distinctly characteristic of the Romanesque period, especially in Italy, and that is the geometrical mosaic work, Fig. 32. It

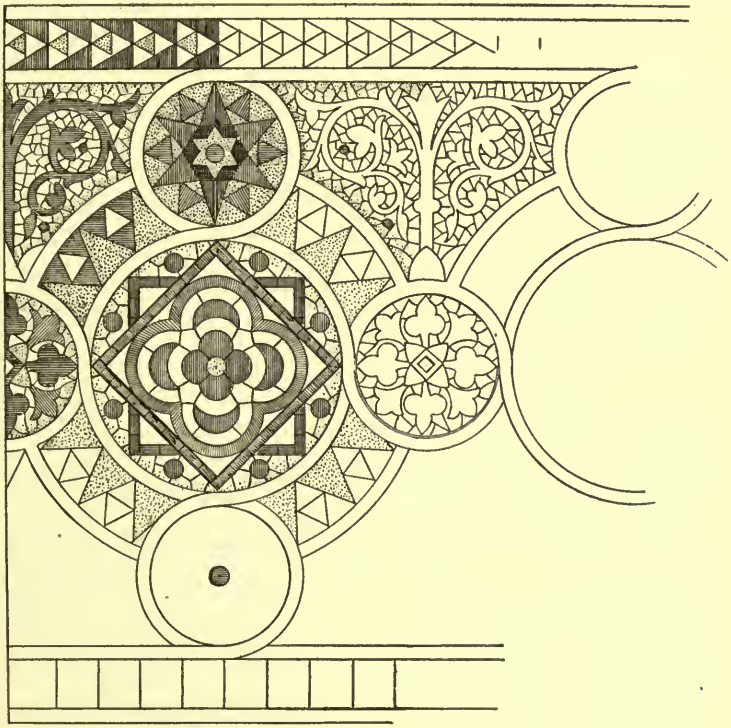


FIG. 32.

consists of an arrangement of small lozenge-shaped pieces of glass in a complicated series of lines, the direction of which is defined by other pieces of different shapes and colors. The examples found in central and northern Italy are much simpler than those in the southern part of the country, and in Sicily, where Saracenic artists introduced their innate love of intricate design, this ornament assumes a most complicated style.

GOTHIC ORNAMENT.

26. We are now entering a period when the art forms of Rome and Greece had been so long unthought of that they were entirely forgotten, and in most localities unknown. The Romanesque builders, in their earliest efforts, had the memory or inheritance of Roman forms and Roman construction to influence their works; but after they succeeded in emancipating themselves from this influence, they never returned to it, and succeeding generations grew up in utter ignorance of the fact that such a thing as Roman art ever existed.

The transition from the round arch of the Romanesque to the pointed arch of Gothic architecture, is readily traced in buildings where the two styles are intermingled, as shown in Fig. 55, *Architectural Design*, § 21, but the passage from the style of ornament of the Romanesque to the variations of that style, as exhibited in the Gothic

FIG. 33.

FIG. 34.

period, is by no means so clear. By this time all traces of the acanthus leaf have disappeared, and a purely conventional style of ornament is prevalent in all buildings of the Gothic style. The nearest approach to the acanthus type is found in some of the illuminated manuscripts of the twelfth century, Figs. 33 and 34, which probably derived many of their features from the ancient Greek manuscript.

Fig. 33 illustrates an ornamental centerpiece geometrically constructed on a circle, while Fig. 34 shows a similar ornament constructed on a square. The foliage in each bears a strong resemblance to the acanthus, but trained more on Gothic lines than the classic leaf. Gothic ornament is usually formed by a continuous stem throwing off leaves on the outer side and terminating in a flower.

Early English ornament is very perfect, both in principle and in execution. There is as much elegance and refinement in modulations of form, as there is in the ornament of the Greeks. It grows naturally from the structural features of the building, and is always in perfect harmony with them. It fulfils every one of the requirements of a perfect style of architecture, but it remains perfect only so long as it remains conventional. As the style advanced from the early English through the Decorative to the Perpendicular period, it became less idealized and more in direct imitation of natural forms, and ceased to be an ornamentation of structural features, but became ornament applied. In the capitals of the early English columns the foliage rises directly from a shaft, which, above the necking, appears to split into a series of stems, each stem terminating in a leaf or flower. This method of decoration is analogous to the mode of ornamenting the Egyptian capital, and is purely original and symbolic. In the Decorative style, however, there is a much nearer approach to nature. It appears to have been no longer possible to treat a natural leaf as a portion of the shaft, and the columns are therefore terminated in a bell-shaped capital around which the leaves are apparently twined, somewhat after the manner of the Roman-Corinthian capital, as shown in Fig. 35, and more

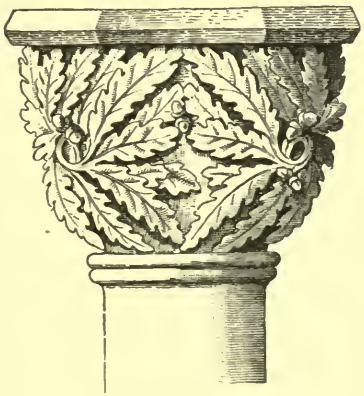


Fig. 35.

and more natural as these become, the less artistic becomes the arrangement. In the spandrels of the arches, too, so long as the conventional style was retained, one vigorous

Fig. 36.

main stem was distributed over the spandrel, from which sprung the leaves and the flowers as in Fig. 36. But when realism was attempted, the stem ceased to be a guiding form of ornament, and lost all grace and architectural character in the endeavor to represent in stone the softness and suppleness of nature. The main stem as a leading feature finally disappeared, and the spandrels are often filled with three immense leaves springing from a twisted stem in the center, Fig. 37, whose position and relation to the rest of the construction affords no explanation of why it should be there.

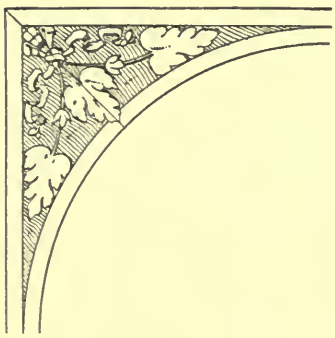


Fig. 37.

The same idea occurs in the bosses which cover the intersections of the ribs of the vaulting. In early English work the stems of the flowers are continuations of the lines of the moldings of the ribs, Fig. 38, while in later periods the intersections were entirely concealed by the overlaying boss,

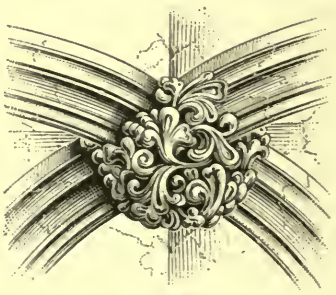


Fig. 38.

as in Fig. 39, which became here simply applied ornament, as were the leaves on the capitals.

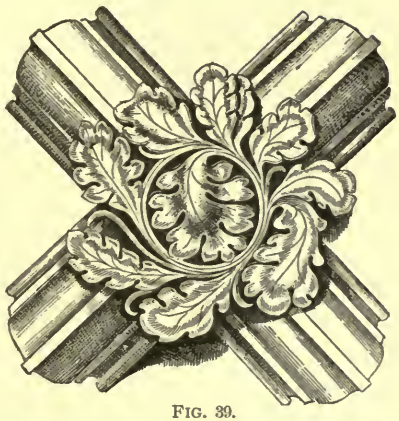


FIG. 39.

27. In the manuscripts and the bookbinding of the twelfth and thirteenth centuries, we find many ingenious geometrical designs with which foliage is combined in order to effect a proper scheme of ornamentation, but illuminated manuscript does not afford a satisfactory guide to the period of any style, as much of it is copied from more ancient manuscripts, and some of it was an imitation of other illuminations of an entirely different origin. Many of the corner pieces, borderings, and designs of pieces executed on the covers, bindings, and title pages were extremely ingenious in conception, and the better of them adhere to the original Gothic system of a wavy parent stem, from which all ornament branched on one side or the other.

28. Modern Gothic work is based not so much on the principle of the old Gothic scheme of decoration as upon direct imitation of Gothic forms. Gothic architecture is, unfortunately, associated, in the mind of the modern practitioner, more with vaulted ceilings and the pointed arch than with the principles of Gothic construction, which are directly responsible for the existence of this form of arch. In the revival of Gothic art, there never appears to have been an honest attempt to reproduce the principles of the Gothic school. Much carving and detail, and even whole sections of ancient structures, have been reproduced and pressed into service to accommodate the demands of modern circumstances, but few, if any, cases exist where the

accurate conventionalism of the early English architecture has been made the fundamental principles of a modern architectural design. The development of the crockets and finials was based upon a close observation of nature, the crockets representing the curled leaves as they appear when they fall from the trees and dry on the ground, Fig. 40, the finials representing bunches of foliage, their sharp, accurate details expressing what they were without particularizing any specific form. In modern work, the crockets and cornice carvings, as shown in Fig. 41, are but an imitation of the

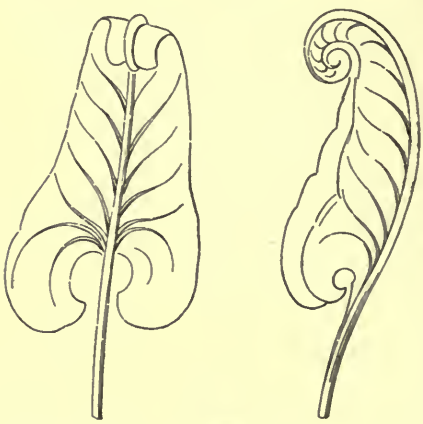


FIG. 40.

FIG. 41.

old crockets, the finials representing, as before, a bunch of leaves or flowers; but effort is made, on the part of the carver, to distinguish what kind of leaves they are, and to give a naturalistic appearance to their shape and position, as if to make them appear more lifelike or to portray them

closely to the type from which they were derived. In addition to this, foliage decoration (on both crockets and finials) is often called upon to express an idea further than its connection with an apparently lost art. The leaves, in some cases, stand in an upright position, as though extending towards the sun, spreading out as widely as possible, touching, and in some cases overlapping, one another, as shown in Fig. 42. Such an arrangement is usually considered to be symbolic of *day*, as opposed to some neighboring and corresponding finial, with the leaves drooping and hanging from the ends of the stems, emblematic of *night*, Fig. 43.

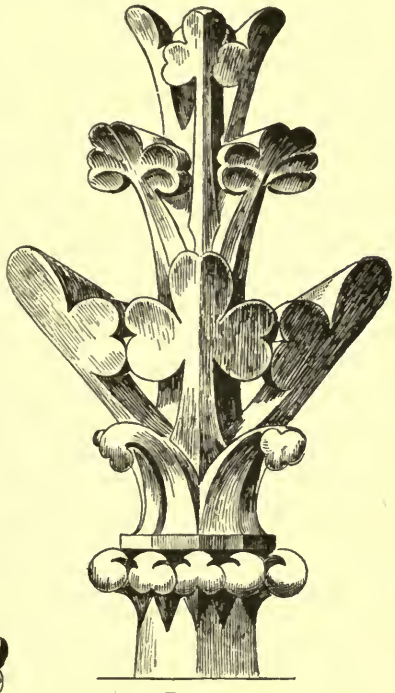


FIG. 42.

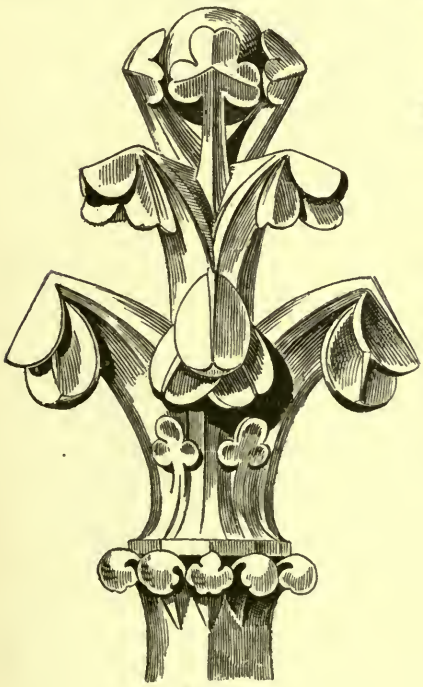


FIG. 43.

29. In surface carving, the leaves and foliage are very much undercut; a branch is twisted and split up into minute

subdivisions, each of which carries a leaf; or some sort of an insect will appear to have alighted on one of the leaves,

FIG. 44.

Fig. 44; all of which is an attempt to execute in stone an expression of lightness and thinness which the material is

FIG. 45.

incompetent to convey. The twisting of the stem, and the arrangement of the leaves to form borders is somewhat on

the original Gothic principle of the wavy stem and tangential branches, but the resulting scrolls are more suggestive of Roman than of early Gothic work, Fig. 45.

30. In English Gothic of old or modern date, much foliated work is carved in wood; the doors to cabinets, the fronts of dressers, the panels of wainscoting, etc. are some-

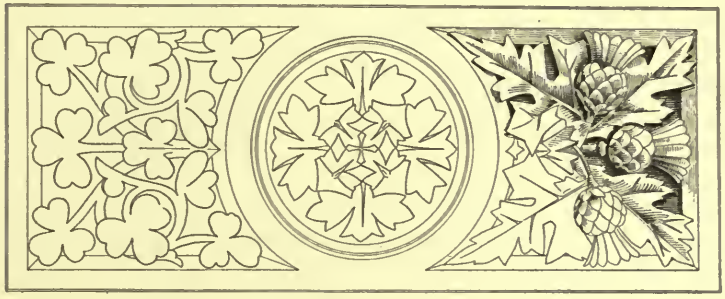


FIG. 46.

times richly elaborated with carved design. These designs frequently include conventional forms of national emblems, the foliage taking the form of thistles, roses, shamrocks, etc., as in Figs. 46 and 47, according to the locality repre-

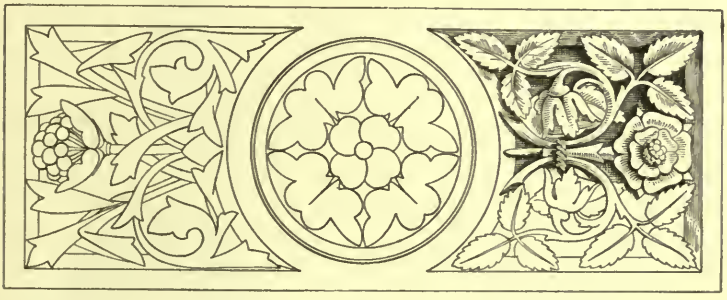


FIG. 47.

sented. While all this satisfies the mind from a symbolic standpoint, it is hardly adequate to permit the designs to be classed as high art, as the execution is after the manner of the Decorative period, where the details are deeply undercut

and adhere closely as possible to the proportions and shapes of the original plants, rather than to their system of growth.

Fig. 48 shows a section of frieze ornament in modern

FIG. 48.

French Gothic. The ornament is much more conventional than the revived English style and is designed more on the lines of the principles of growth than on the accuracy of form of the type.

31. Throughout all ages, we have seen that art and ornament were more or less affected by the style which preceded them.

The acanthus leaf, originally conventionalized by the Greeks, was adopted by them direct from nature and

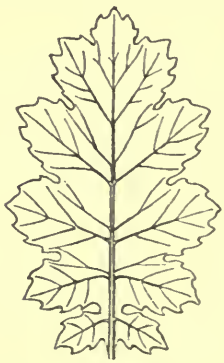


FIG. 49.

FIG. 50.

bequeathed to the Romans, who materially altered its mode of treatment before handing it down to the next architectural generation, the Byzantine.

Fig. 49 shows the natural acanthus leaf as it would appear pressed out flat, while Fig. 50 shows the calyx of the acanthus, with the leaves and flower. The Greeks conventionalized the pressed leaf into the form of Fig. 51 and carved it as shown in Fig. 52. When the Roman school of art

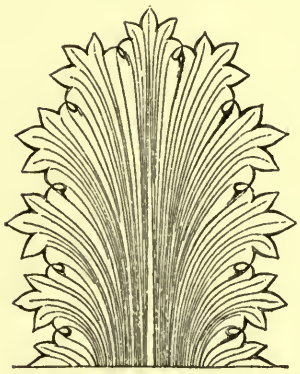


FIG. 51.

FIG. 52.

took up the acanthus, they modified it to the form of Fig. 53, and so carved it on their Corinthian capital.

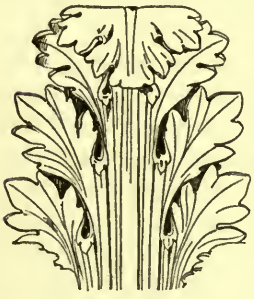


FIG. 53.

Such was the acanthus throughout the entire Roman period; but with the inspirations and encouragements of a new school of art, we find the leaf gradually assuming some of its old form and refinement, until, with the building of the Church of Hagia Sophia, we see it carved in the sharp and expressive form of Fig. 29. In the Romanesque church at St. Denis, France, we also find it in an advanced stage of improvement, as shown in Fig. 54, and we can follow its steady advancement towards an ideal form, until, at the birth of the Gothic school,

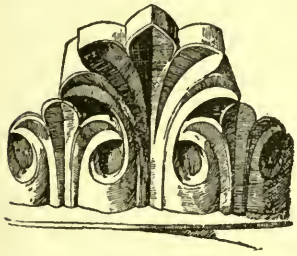


FIG. 54.

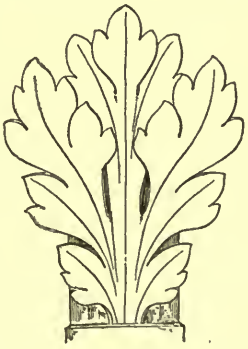


FIG. 55.

it was shut out entirely as a thing that was heathen and wicked.

Its ostracism was hardly universal, however, for in Italy and the south of France we find a Gothic leaf like that in Fig. 55, which could have had for its prototype none other than the classic acanthus.

RENAISSANCE ORNAMENT.

ITALIAN RENAISSANCE.

32. Modern buildings, when designed in the style of the Renaissance, are classified according to the period of the style, when we refer to their interior decoration or furniture; and nearly always according to the country of the style's local development, when we refer to the exterior or to the building as a whole. The exceptions to this rule are the Renaissance and revival designs in Great Britain, where the name of the period is usually applied to the design of both the exterior and interior. For instance, we speak of a building as being in the style of the French Renaissance when we are describing the effect of the whole structure; but we refer to the rooms of its interior as being in the style of Francis I, Henry IV, Louis XIV, etc., all of which are distinctly French Renaissance, but each one is a particular period of it, and differs materially from both its predecessor and successor.

In speaking of the architecture of Great Britain, we describe the buildings as Elizabethan, Queen Anne, or modern Gothic, whether we refer to its exterior detail or its interior arrangement. It will, therefore, be clear to the student, that a comprehensive understanding of the distinctive characteristics of the styles of the different periods is absolutely necessary to the creator of a perfect design.

33. The general character of the style of Italian Renaissance, as regards the exterior designs, and the causes leading

up to the change, are described in *History of Architecture*, to which the student is referred.

The ornament in the Italian Renaissance style is of the same general character, whether used in the Florentine, Venetian, or Roman school, and in modern work the architect designs the interior of his edifice without much regard to the local school in which the style of the design was perfected. A slight exception to this might be mentioned in special cases where the architect, for local or individual reasons, desires to give the building a somber, severe appearance, and molds his design on the style of the Florentine school; or, where the lightness and delicacy of the Venetian school would, with its slightly Byzantine tendency, better suit some peculiar characteristic of the proposed design; or, where, as in the design of a palace or public building, the luxury and grandeur of the Roman school might be singularly appropriate.

The most important thing to be borne in mind is that in designing a building in any style, the end to be sought is not the faithful reproduction of any detail or group of details characteristic of the period of the style, but the expression in the design of the temperament and circumstances which caused the style to exist.

Fifteenth-century Renaissance was an attempted reproduction of the ancient Roman customs. During this period the people over all civilized Europe imitated the classic manners, the Roman style of dress, and the Imperial system of government.

The principal rooms of a palace or villa had side walls divided into a number of panels, as shown at *a*, Fig. 56, these panels being separated by a semidetached column or a pilaster and pedestal, as at *b*, which extended to the top of the panels and supported a full entablature *e* under the ceiling.

The top moldings *h* of the pedestal *g* were carried around the room over a marble wainscot, or dado, *k*, and the lower members, or moldings, *l*, were carried under the dado to form a base. When the column or pilaster was used without

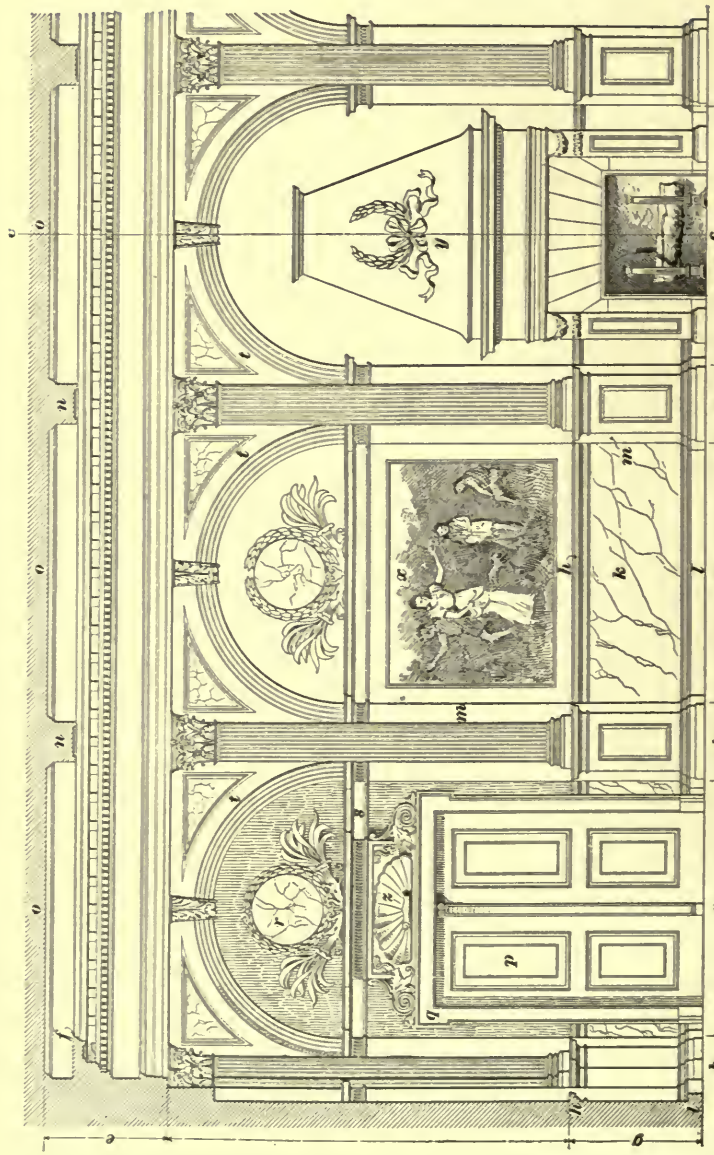


FIG. 56.

a pedestal, it stood upon a high plinth, and the moldings of the base around the room stopped against the projecting plinth, while the moldings on the base of the column or pilaster stopped against the impost pier *m*. Upon the top or crown molding *f* of the entablature rested, in a line with each pilaster, a ceiling beam *n* which divided the ceiling into a number of square panels *o*, each of which was decorated with paintings or frescoes. The center lines of doors, windows, and other features were located exactly in the center of these wall panels, as at *c c*, and each feature became a means of ornament therein. The doors were liberal in dimensions and surrounded by a trim *q* richly molded, as were also the panels at *p*. Above the door head was usually a heavy carved ornament *z* reaching to the springing line of the wall arches *t*, which were the usual finish to the panels bordered by the pilasters. At the spring of the arch itself the impost moldings *s* were carried across the wall panels, and the semicircle thus formed was ornamented with a marble *cartouche*, or carved wall ornament *r*. The spandrels *t* were paneled with rich marbles or sometimes with frescoes, and the capitals of the pilasters were frequently gilded to represent solid gold. Where the wall panels were open from top to bottom, they were usually decorated with paintings or hung with tapestry, as at *x*. These tapestries were woven of the most costly materials and hung loosely in frames built in the walls. They were usually designed in brilliant colors representing religious subjects, as contrasted with the painting of mythological deities seen on the ancient Roman walls.

The central panel of the room occasionally contained a large open fireplace and mantel *y*, with andirons typical of the Roman style, or a brazier identical with the classic design.

34. In the interiors of these palaces and villas, which are more closely allied to the purposes for which most modern structures are embellished, we find extravagant elaboration by the artist and the sculptor, highly enriched columns and

pilasters, and a decided taste for gorgeously painted or decorated ceilings. The shafts of the columns, the faces of the pilasters, and the friezes of the entablatures are rich with sculptured and painted ornament, in many cases more extravagant than the decorations of the Palace of the Cæsars.

FIG. 57.

Fig. 57 is a portion of the shaft of a column in a tomb at Rome designed by the celebrated architect, Sansovino, and shows the style and extent of this columnar enrichment. The capitals of these pilasters and columns were usually a modification of the Corinthian or Composite order, but their alterations in many instances were so extensive that recognition was scarcely possible.

Fig. 58 is a pilaster capital from the Scuola di San Marco, at Venice, and Figs. 59 and 60 are carved wooden capitals from

FIG. 58.

FIG. 59.

pilasters in the Palazzo Vecchio, at Florence. In many instances, especially in modern Renaissance work, these

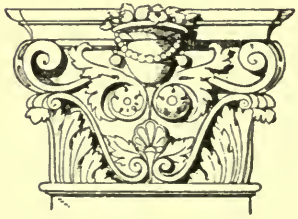


FIG. 60.

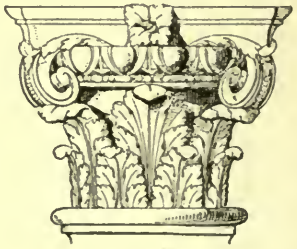


FIG. 61.

pilasters are executed in plaster, with their capitals gilded, and the arabesque or scroll ornaments in the panels are wrought in bas-relief or painted in rich, harmonious colors.

35. The capitals of columns are also very frequently gilded, while the shafts, made usually of rich and costly

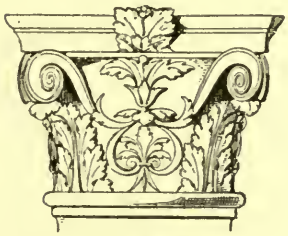


FIG. 62.

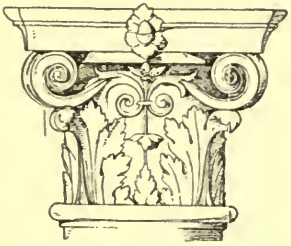


FIG. 63.

colored marbles, are seldom grooved or fluted, but finished with a high and brilliant polish. The Composite and Corinthian orders are the principal ones here used, as with the pilasters, and occasionally preference is given to a very much modernized form of the Roman Ionic, but the Doric and Tuscan are rarely seen in Renaissance work. Fig. 61 shows a Composite capital of the Italian Renaissance style, and Figs. 62, 63, and 64 show the variety and extent of mangling to which the Corinthian forms were subjected to make them suit the taste of the Renaissance designer. Fig. 62 is from the Palazzo Scrofa, and Fig. 63 is from another design of Sansovino's, at Rome.

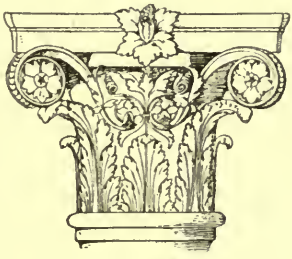


FIG. 64.

FRENCH RENAISSANCE.

36. Renaissance ornament, as seen in France, is divided into four general periods, each distinguished by the name of the sovereign most prominent in the encouragement of art during each epoch.

The first period, that of Francis I, extends from about the year 1483 to 1560. The second period, known as that of Henry IV, extends from 1560 to 1642. The age of Louis XIV, as the third period is called, includes the years from the end of the last epoch to the French Revolution in 1792. The period of the Empire extends from the reign of Napoleon I down almost to the present day, although the style of ornament peculiar to this epoch was developed almost entirely before the end of the reign of Louis XVIII, in 1824.

There is a marked difference in the progress and development of Renaissance ornament in France, as compared with that in Italy. Surrounded by the classic forms and ruins of antiquity, the Italian artists could not cultivate a taste for Gothic forms, and after a short struggle with medieval art, they returned to the style of ancient Rome. Further, the Italians were direct descendants of the very authors of these classic forms, and naturally inherited a latent taste for them; while the peoples to the north and west were the posterity of half-savage tribes, who, though they conquered Rome, lacked the culture and refinement necessary to appreciate the art of their vanquished neighbors.

37. Francis I, king of France, being much impressed by the new art forms he saw in Italy, invited several Italian architects to Paris to execute some work for him. Italian Renaissance ornament was thus introduced into France in its pure form, and many of the monuments built by these imported artists are decidedly more Italian than French.

The workmen, however, were natives of French soil, and had learned their trades and derived their experience on Gothic structures under the direction of Gothic architects; hence the earliest Renaissance ornament in France is tainted with Gothic lines, and even the Italian masters could not get pure classic detail from under the chisel of the long experienced Gothic stone carver. When the Gothic architects themselves attempted to design buildings in the style of the Roman school, the results naturally exhibited the thirteenth-century training, and the ornament of the period

of Francis I is thus an imitation of the Italian forms executed with Gothic materials.

Exteriorly we see the high-pitched roof and pointed gables of the former period intermingled with the arabesque pilasters and Corinthian capitals of the Italian school. Within the walls we find the long, narrow panels, the elliptical arch, and the twisting, flamboyant lines, so prominent in the declining days of the Gothic school; but the columns, pilasters, moldings, and carvings savor strongly of the classic model. As the style advanced, the classic influence became more marked, and the vertical lines, so characteristic of the Gothic school, began to divide honors with equally important horizontal lines of classic origin. Finely molded belt courses at the sills and heads of the windows marked the different stories, and were crossed by a system of vertical lines formed by superimposed pilasters, flanking the windows continuously from basement to roof.

Elaborate dormer-windows, with high and ornate gables and pinnacles, diversified the high-pitched roof, and the pilasters were treated like long panels and ornamented with arabesques of great beauty. The moldings were fine, delicate, and richly carved, and stone-mullioned windows were preferred to the more generous openings seen in the Italian buildings. High dormers and round-corner towers with turrets and pinnacles carried to excess were features of this period that continued late into the succeeding styles.

38. As the style of Francis I advanced to the middle of the sixteenth century, it lost much of its earlier charm. The orders were used with increasing frequency, and conformed more closely to antique precedents. Facades were flatter and simpler, cornices more pronounced, and the arches were heavier in style and more Roman in their general treatment, while the delicate arabesques, so characteristic of the early part of the period, gave way to a heavier style of carving and ornament. With the period of Henry IV, Renaissance ornament had taken a firm hold on the

architecture of the country, and Gothic detail was considered obsolete. But the French architects had learned their art in the Italian schools, and Henry IV had married an Italian queen, so that one could hardly expect other than a close imitation of the Italian forms, with less and less individuality as the style advanced.

The characteristics of this period belong more to external architecture than to interior decoration, and consist of a close imitation of the classic orders, with the rustic stonework of the Florentine school, and the large, airy openings of the Roman Renaissance, as described in *History of Architecture*. In interior work, large arabesque pilasters, elaborately paneled wall decorations, heavy moldings, and large projecting cornices seem to be preferred, while the hangings and furniture are suggestive of the luxury and idleness of the days of the reign of the Cæsars.

39. The period known as the age of Louis XIV covers the reign of that king, as well as that of his two successors, Louis XV and Louis XVI. This was an age of remarkable literary and artistic activity, as well as of progression. A style of ornament developed in the reign of Louis XIV can be traced through the sovereignty of each of his successors, and the changes wrought upon it clearly observed.

The general character of Louis XIV style is even more classic on the exterior than that of the Henry IV period, but it is also free from the extravagances of the Italian school seen in contemporaneous buildings. This is probably due to one circumstance more than any other, and that is the fact, that Lorenzo Bernini, the celebrated Italian architect of St. Peter's colonnade, was invited to France to prepare plans for the Louvre Palace, and that, after doing so, his plans were not accepted by the king, who preferred the design submitted by Claude Perrault, a French physician. This preference of a native artist to the celebrated designer of St. Peter's colonnade materially lessened the influence of the Italian school in French art, though we find the resulting structure of Perrault conforming closely to the Roman

orders as analyzed by Palladio; it is at the same time quite free from the vagaries exhibited in the later days of the Italian Renaissance.

40. Fig. 65 is a form of leaf ornament much used in the arabesques of Italian Renaissance design during the period

FIG. 65.

when Francis I and his predecessors, Louis XII and Charles VIII, invaded Italy. Its character is free and untrammeled, apparently governed by no rule which bids it turn one way or the other. It was usually carved in low relief, though at times it displays the tendency, which developed later, of becoming undercut and exaggerated. Contemporaneous with this, in France, the Gothic architect was carving a leaf ornament similar to Fig. 66. The motive is almost circular and the character is not free and open like the former, but

FIG. 66.

cramped, contracted, and apparently restrained by some fixed rule. The branching edges of the leaves show a partly controlled tendency to open out, as they did later, in the flamboyant period of French Gothic architecture, but as yet have not done so.

Thus, when the Italian architects imported by Francis I turned their wild, free, voluptuous designs over to the Gothic stone cutters, the latter could not execute them without curbing some of that freedom and reducing the form to some of their ideas of governing rules. Hence, we see in the early part of the period of Francis I a leaf ornament somewhat resembling that shown in Fig. 67, which is the Italian leaf cut on Gothic lines.

FIG. 67.

41. During the reign of Henry IV, the ornament expanded and approached more nearly the Italian form. It never lost its tendency to curl up tightly, however, and all

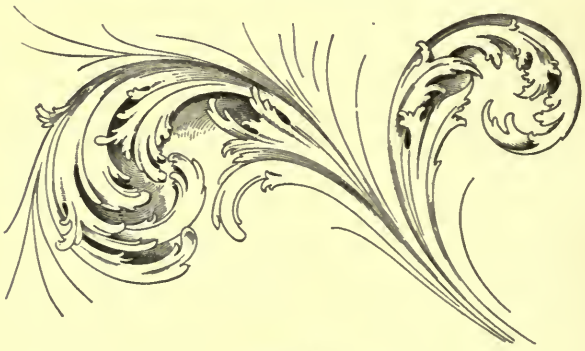


FIG. 68.

attempts to relieve it of this tendency were failures. By the time of the reign of Louis XIV it had become even

more free and luxurious than its Italian prototype, and its use, no longer confined to arabesques on friezes and pilasters, extended to the ornamentation of picture frames, furniture,

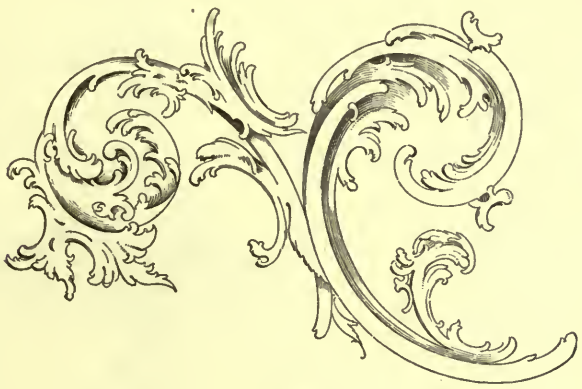


FIG. 69.

candlesticks, and to every utensil imaginable in household use, as well as plaster mural ornaments and jewelry. Fig. 68 shows the character of the ornament at this time, while

FIG. 70.

Fig. 69 shows its form during the reign of Louis XV, when it had reached the full extent of its meaningless development, generally known as *rococo*, a French term signifying frivolous. It became a trifle more intelligible during the

reign of Louis XVI, as the leaves were then more clearly defined, but the extravagances of its lines and curves never abated, as shown in Fig. 70.

Rococo ornament pervades all French Renaissance work to a greater or less degree, except during the period

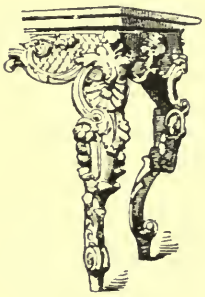


FIG. 71.

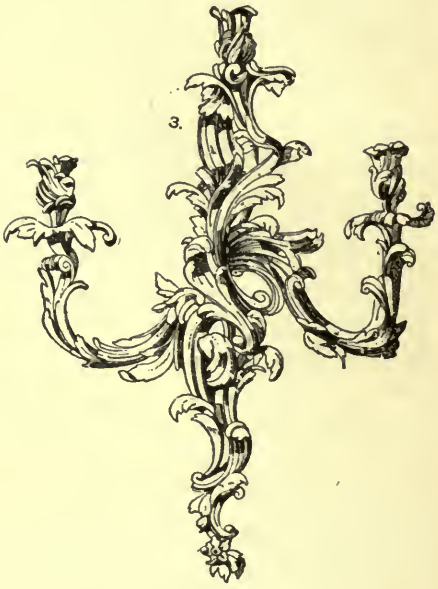


FIG. 72.

of Francis I. Fig. 71 shows the ornament as applied to the legs of a small table in the Louis XIV style, while the three-branch candlestick in Fig. 72 shows the rococo design carried to its most exaggerated form.

ENGLISH RENAISSANCE.

42. The close of the Francis I period in France corresponds in date 1559 A. D. with the beginning of the Elizabethan period in England; but, as each of these styles marks the transition from Gothic to classic forms, they are usually considered as contemporaneous.

The Elizabethan style can hardly be considered as successful as its French contemporary, and its immediate successor, the Jacobean style, has nothing to recommend it. The age of Elizabeth, as the early part of this period is frequently called, is very important on account of the great

advance in residence and educational architecture, but, unlike the preceding architectural period, it is entirely devoid of any ecclesiastic structures of importance.

43. In describing the character of Elizabethan ornament, a comparison of the circumstances of its birth with the circumstances of the advent of the more successful French style, is desirable. In France, the classic details mingled with the Gothic forms very sparingly at first and were imported direct from Italy, the land of their origin, while in

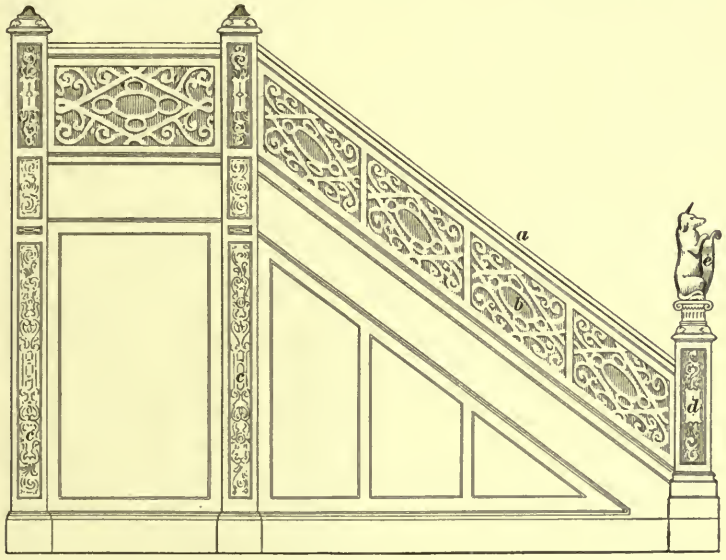


FIG. 73.

England the intermixture was excessive from the beginning, and the classic designs were borrowed, not only from Italy, but also from France, Netherlands, Germany, and other localities, after these countries had already modified and corrupted them.

The Gothic system of construction was entirely opposed to the classic detail, and the ornament of this period is, therefore, applied to the surface rather than formed with the construction; and, when details from the orders could not be applied as ornament, the architects invented forms which

were as meaningless as they were inappropriate. Elizabethan ornament, therefore, presents to us a grotesque and complicated variety of pierced scrollwork, as shown in Fig. 73, where the stair rail *a* is supported by the scrollwork paneling *b* cut out with a fret saw, the members being afterwards carved to form intertwinings. The ornament on the pilasters *c* and on the newel *d* is raised, the background being cut away to relieve it. A corrupted form of the Ionic cap used as a newel head is very common in this and the Jacobean periods, and is usually surmounted with a griffin or other grotesque animal supporting a shield *e*, on which is carved the owner's coat of arms. Besides this scrollwork, we see a great variety of interlaced bands, sometimes of a geometrical pattern, as in Fig. 74, but generally flowing and capricious; also, strap and faceted bands, as in Fig. 75, where pyramidal facets *a* and oval pateræ *b* are planted on the bands and give relief to the surface. Carved and broken outlines, festoons of fruit and drapery interspersed with human figures and grotesque monsters, and here and there a design of a leaf or branch constitute other types of this ornament. Where columns or pilasters were used, they were frequently square in plan, and often had a decided taper from top to bottom, as in Fig. 76.

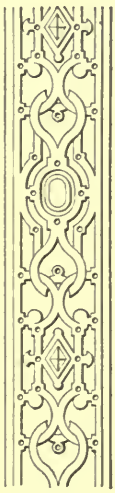


FIG. 74.

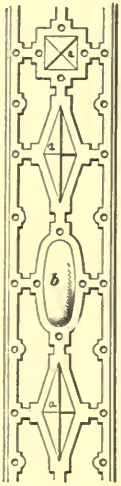


FIG. 75.

FIG. 76.

During the reign of James I these corruptions of classic detail were even more exaggerated. The orders were used to great excess, and were treated without correctness of position or grace of proportion, and the ornament was bold, heavy, and over

assertive. In fact, English architecture was on a rapid decline, but was rescued by the revival of the Gothic at the close of the century.

Notwithstanding the paucity of the ornament and general design at this period, there is much to be learned from the general arrangement of the edifices; therein we begin to see the refining influence of advanced society, and the demand for household comfort and luxury.

44. This closes for the present the discussion of Renaissance ornament as it existed at the time of its fullest development in the sixteenth century. We have seen the classic forms interpreted by different architects, in different countries, to entirely different significations, according to the geographical position, methods of living, and system of government of each people.

45. Nineteenth-century, or modern, Renaissance should not, therefore, be an imitation of the style prevailing in Italy, France, England, or Germany during the period embraced between the years 1500 and 1700 A. D., as that style was in itself an imitation, and in many localities a very corrupt one. On the contrary, the modern design should be, as was the original Renaissance, an attempted reproduction of the ancient classic forms, adapted to existing conditions. As the parent style was governed by the influences of the fifteenth century, so should modern Renaissance be made to conform to the tastes, environments, and improvements of the nineteenth. In other words, the architect, in preparing his Renaissance design, should imbue himself with the spirit of a fifteenth-century designer, possessed with a knowledge of nineteenth-century conditions.

The spirit and principle of modern work would, therefore, be identical with the original style.

NATURAL LEAVES AND BLOSSOMS.

46. From what has been said in the preceding pages, it should be apparent that, in the best periods of art, all ornament was based upon the principles which regulate the

arrangement of form in nature, rather than upon an attempt to imitate absolutely the forms themselves; whenever this limit was exceeded, it was a most prominent indication of a decline in the art. True art consists in idealizing, and not in copying, the forms of nature.

At the present day, the tendency in art is towards the faithful reproduction of forms as works of ornament. The general public sentiment mistakes fidelity of execution for artistic value, when, as a matter of fact, true art exists in an ornament before the work is executed or even commenced. It is in the mental ideal that the artistic value lies, and accuracy of execution is to be commended only when it faithfully portrays the ideal, and not the type from which the ideal springs. The world is becoming tired of constant repetition of the same conventionalized forms, which are identified with the styles of the past ages, and therefore have little sympathy with the conditions of today, and a demand has arisen, that "we shall go back to nature" for an inspiration, as the ancients did. This advice is well enough in its way, but what shall we go back to seek? If we go back to nature as the Egyptians and the Greeks did, we may succeed in improving somewhat upon the present form; but, should we turn to nature as the Gothic artists of the fourteenth and fifteenth centuries did, we should gain little or nothing. As explained in Art. **26,** the ornament of the early English period was analogous to the Egyptian ideal; but the servile imitation in subsequent centuries destroyed the artistic expression.

47. By the ornament of a building, we can judge truly of the creative power possessed by the artist and expressed in his work. The general proportions of the building may be good, the moldings may be accurately profiled after the most approved models, the arrangements and subdivisions of the plan may be most ingenious; but the instant ornament is attempted, we can see to what extent the architect is an artist. Ornament is the best measure of the care and refinement bestowed upon the work. It is no easy task to put

ornament in the right place, and in the right place only; and to express in the ornament the intention and purpose of the whole structure, is still more difficult.

In architectural practice at the present day, it is not unusual to leave in the hands of the draftsman the ornament of certain structural features of a building, and particularly the details of the interior decoration. By this means, much ingenious but decidedly inappropriate design is applied to certain details that do not require any ornamentation whatever, while vast surfaces of wall or roof are left bare, when a certain amount of surface decoration would relieve them. In Renaissance work, particularly, is ornamental form warped out of the true path and theory of applied decoration. The acanthus leaf, which is so prominent in Roman art, and carried from that into Renaissance design, lends itself so readily to the manufacture of ornament, that it has deadened the creative instinct in artists' minds. With the use of the acanthus, ornamental design has been so limited that the architect has left to another what appeared so simple to do, and thus abdicated his high position as architect and head and chief of the building operations. How, then, is the desire for progress to be satisfied? How is any new style of ornament to be invented or developed? It certainly is not dependent upon a new style of architecture, as it has been already shown that the desire for works of ornament is coexistent with the earliest attempts at civilization of every people—architecture adopts ornament, but does not create it.

48. The Corinthian order of architecture is said to have been suggested by the observation of an acanthus leaf growing around the outside of an earthen flower pot. The acanthus existed as ornament long before this order was invented, and it was a peculiar application of the leaf to the formation of the capital of a column that led to the invention and creation of the Corinthian order.

The principle of the foliation, and even the general form of the leaves which predominate in the architecture of the

thirteenth century, existed long before in various illuminated manuscripts; and as these manuscripts were of Eastern origin, we can see an oriental character expressed in the early English ornament. The floral style, in direct imitation of nature, which succeeded early English architecture, was preceded by the same style in works of ornament. The facility of painting flowers in direct imitation of nature in the pages of manuscript, induced an attempt to rival them in stone, in the buildings of the time. The architectural ornament of the Elizabethan period is mostly a reproduction of the works of the weaver, the painter, and the engraver. The artists of the Elizabethan age were much more familiar with paintings, hangings, furniture, metal work, and other articles of luxury which England obtained from her neighbors on the Continent, than they were with the architectural monuments of ancient Italy, and it is this familiarity with the ornamentation of the period, but imperfect knowledge of the architecture, which developed the distinguishing peculiarities and characteristics of the Elizabethan style.

49. It may be argued, therefore, that an entirely new style of architectural ornament may be developed independently of a new style of architecture, and, moreover, it would be one of the readiest means of arriving at a new architectural style. For instance, if we could only invent a new termination for a column, or other means of support, one of the most difficult points in the determination of an architectural style would be accomplished. The structural features of a building which form an architectural style are: (1) the means of support; (2) the means of spanning the spaces between the supports; and (3) the formation of the roof. The decoration of these structural features forms the characteristics of a style, and as they all follow naturally from one to another, the invention of one would determine the rest.

The architectural profession of the present day is too much under the influence of past education on one hand, and an ill-informed public on the other, to effect a radical

change in architectural style; but a future generation of both classes, born under happier circumstances, will develop what appears hopeless today. It is for the benefit of posterity that the present age is studying and copying works of the past; this servile copying will soon become irksome and lead to an architectural revolution, which will bring about a change in style.

50. In designing any ornamental form based on organic nature, it is best to assume a pictorial idea of that natural type in a conventional or geometric sense. A common dog rose and its leaves and buds have a certain geometric formation, which is characteristic of the flower and may be expressed in plan and elevation, so to speak, somewhat as shown in Fig. 77. At (*a*) in Fig. 77, is shown what we may consider a plan of the blossom; (*b*) is an elevation of the half-blown bud, and at (*c*) is shown an elevation of the closed bud; (*d*) shows the form of the leaves, their arrangement on the stem, and their relative sizes according to their positions. In expressing this flower in any form of ornament or decoration, the principles of its growth are all that need be expressed; an accurate portrayal of the details of the flower, in outline and color, is not high art, nor is its inappropriate application to a surface at all commendatory, no matter how well it may be conventionalized.

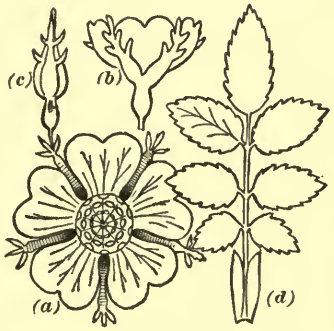


FIG. 77.

51. All flowers may be reduced to a similar geometric system, and after being geometrically drawn they can be conventionalized by eliminating from their portrayal every line not necessarily connected with the principle of growth, on which the flower depends. At (*a*) in Fig. 78 is shown a plan of the morning-glory blossom; at (*b*), a side elevation

of the blossom; and at (*c*), an elevation of the closed bud. The twisted form of the petals in the closed bud never occurs as evenly in nature as in our illustration, but it is not the less a fact that in closing for the night, the petals of the morning glory, or convolvulus, assume a spiral position, which the form shown at (*c*) somewhat conventionalizes. At (*d*) is a natural outline of the pressed leaf, which is conventionalized sometimes into a mere isosceles triangle, and at others to a spear-head form, either of which shows the distinguishing characteristic of the leaf in its long, narrow, pointed form. The periwinkle, a flower similar in some respects to the one just described, is shown in Fig. 79. Its plan (*a*) shows the petals to be more independent of one another than in the plan of the morning glory, Fig. 78. Its elevation (*b*) shows the trumpet shape somewhat similar to the elevation of the morning glory, but flatter on top and straighter in the tube. The leaves are shown at (*c*), not in plan, as in Figs. 77 and 78, but in elevation, because their peculiarities and distinguishing characteristics are best seen in elevation, and it is in this form we usually see the flower conventionalized when used in any ornamental design. Fig. 80 shows the natural growth of the honeysuckle, while Fig. 81 shows the conventionalized elevation of the honeysuckle and its leaves. The usual irregularity of arrangement of each blossom is curbed into position and shape in Fig. 81, so as to form a geometrical figure. The leaves are treated in the same manner as were those in Fig. 79, though reference

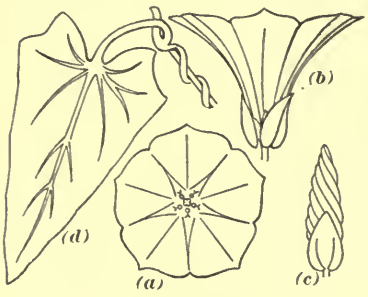


FIG. 78.

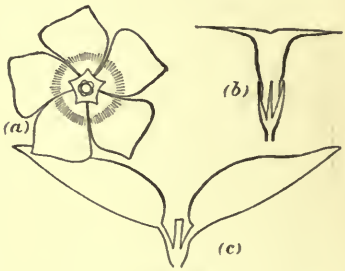


FIG. 79.

to Fig. 80 will show that they do not grow thus stiffly, though they do spring from opposite sides of the main stem, precisely as indicated. It would be a difficult matter to trace all the

FIG. 80.

evolutions that Fig. 81 must have passed through in order to finally arrive at the shape of the palmette so characteristic of Grecian art. But, notwithstanding the remoteness of the conventionalized Greek form from the original type, the

resemblance of the individual figures of the palmette may be traced to the petals in the elevation, Fig. 81.

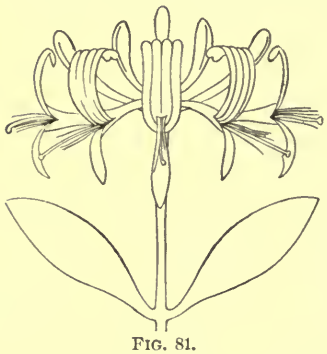


Fig. 81.

52. Fig. 82 shows a similar rendering of the passion flower, where the plan and side elevation of its blossoms and its leaves are brought into a design, to show its system of growth. The characteristics of the passion flower lie in its peculiar radiating petals, its raised and mushroom-like pistil, and the five-lobed form of its leaves. These characteristics furnish motives that may be easily conventionalized

Fig. 82.

and lead to the development of an original scheme of ornament.

From these few examples, then, it should be apparent that it is entirely unnecessary for a modern artist to do anything but copy the five or seven lobed flowers so well patronized in the thirteenth century, or to imitate the honeysuckle of the Greeks or the acanthus of the Romans. All natural forms have unvarying principles, and by close observation of the principles, rather than the form itself, an original, true, and satisfactory end may be reached from our efforts.

PRACTICAL PLANNING.

INTRODUCTION.

53. The *practical* designing, the preliminary planning, and the original conception of the scheme of a building, are most important steps in the composition of a design, and require more careful deliberation than any other part of an architect's duties. These requirements mean more than simply arranging the requisite number of rooms on the drawing, crowding the greatest number of apartments into the smallest amount of floor space, and designing a picturesque elevation of the front. The *practical* plan comprises the most convenient arrangement of all the rooms and apartments necessary to the purposes of the building, the proportioning of these rooms to each other and to the whole structure, the simplest means of access to, and communication between, all apartments where such communication is required; and all this is to be so accomplished that the lines of the plan will be in harmony with the grouping and repose desired to be expressed in the elevations.

54. The architect requires to be thoroughly familiar, not only with the purposes for which the building is to be erected, but also with the character of the materials of which it is to be built. If the proposed structure is to be a church, then

the architect must thoroughly inform himself on every detail and tradition of its service; if he is to design a hospital, then his knowledge of the requirements of the patients, of the duties of the nurses, and of the system followed by the doctors, will be severely taxed as he works out the plan; and it is certainly clear that, no matter how minute may be his instructions for the building of a mansion, no architect would be qualified to execute the work without an intimate acquaintance with the domestic and social habits of the upper classes of society. The successful architect must, therefore, be prepared to devote a liberal amount of time to the study of the *purpose* of the building, before he prepares the plans, or even conceives any definite idea of the arrangement or grouping of the parts.

55. The **purpose** of the building will very largely determine the architectural style of the design, and the style and purpose combined will suggest the material, although locality, climate, surroundings, and local conditions will generally determine the material. Art galleries, museums, civil government buildings, etc., whose purpose is the protection of valuable papers and records, are usually built in the *classic style*, and this style, combined with the permanency and durability required by the purpose, determines that the building shall properly be of stone.

If the purpose of the building is of a temporary character, as were the buildings of the international exhibitions at Paris, or at Chicago, the style might still be classic, but the material could be of iron and wood, finished and decorated with plaster, stucco, etc., as many of them were. However, if the structure is to be of stone, then the climate will determine the kind of stone best suited; the surrounding buildings or landscape will, in some degree, determine the color of the stone, and the hardness or softness of the stone will determine the amount of detail which may be cut in it, thereby influencing, more or less, the architectural style of the structure. Thus, we see that all this complexity of details must be judiciously considered before the plans are commenced.

56. The Site.—In *History of Architecture*, we read that the Walhalla, a beautiful model of the Parthenon, failed entirely in artistic effect, because its site was surrounded by the incongruous roofs and spires of the German villages, thus showing that locality, as well as purpose and material, should influence the proposed design. When a building, whatever its purpose, is erected on the summit of a lofty hill, or on the side of a mountain, without other surroundings than those provided by nature, its design should partake somewhat of the wildness of its position. It should appear strong, crude, and able to protect its occupants against the elements or invasion. On the other hand, when a building is erected in the bustling part of a busy city, surrounded by multi-storied office structures or factories, it should have the appearance of consistency with its surroundings, and should well express the purpose to which it is devoted. In private-residence architecture, the taste, social position, and disposition of the owner will materially affect the design, as will also the locality, whether city or suburban. Residences built in mountainous localities should be entirely unlike, in appearance, the dwellings along the seashore, and a house built in France would, of course, be entirely unlike a residence in America. Different countries, as well as different states in the same country, vary in the style and plan of their houses in the same proportion as they vary in the temperament and customs of their inhabitants.

PROPRIETY OF STYLE.

ITALIAN RENAISSANCE.

57. In nearly all countries it is customary to give preference, in residence architecture, to the style in which the dwelling house was originally developed in each particular country. In Italy, we see in nearly every modern residence some attempt towards the Renaissance in design. With the exception of Venice, Gothic art prevails in none of

the cities, and even there it is so modified by local treatment that it is generally referred to as Venetian Gothic, to distinguish it from the French or English styles of the same

FIG. 83.

period. In Rome, Florence, Genoa, and other important cities, the prevailing style is Renaissance, and, as has been said before, there is in the Roman school of Renaissance

much that can be profitably studied in designing the modern city residence—whether it is the residence of an individual, as the private dwelling, or the residence of a number of individuals, as the hotel or club house. Fig. 83 is an elevation of the front of a residence in the style of the Roman school of Renaissance, and in Fig. 84 is shown the facade of the Century Club, in New York City, designed in the same style. The former of these exhibits the simplicity of arrangement of openings which can be made to give dignity and character to the front, behind which one can judge at a glance that there is a simple arrangement of rectangular rooms, disposed so that due advantage can be taken of the outlook from the front and rear of the building.

58. The treatment of the openings in the second and third stories of Fig. 83, with Doric and Ionic pilasters or semidetached columns, is characteristic of the Roman Renaissance; and this, combined with the alternating triangular and segmental pediments, is suggestive of the treatment of the facade of the Farnese Palace, shown in Fig. 94, *History of Architecture*. The contracted openings and the rusticated stonework of the first story are more in harmony with the Florentine school than with the Roman, but they suit their position here most excellently, as they give a solid and massive appearing base for the superstructure. The division of the facade into three component parts, basement *a b*, superstructure *b c*, and roof or cornice *c d*, is very nearly in the proportion of the pedestal, column, and entablature of an order.

59. In the facade of the Century Club, Fig. 84, the conditions are entirely different, yet the same school of design suits admirably. Here we have a building apparently but two stories in height, the lower one being of heavy, rusticated stone blocks, with little or no ornament, while the upper story appears light in construction, rich in ornamentation, and symmetrical in design.

As a matter of fact, this building is not two, but four

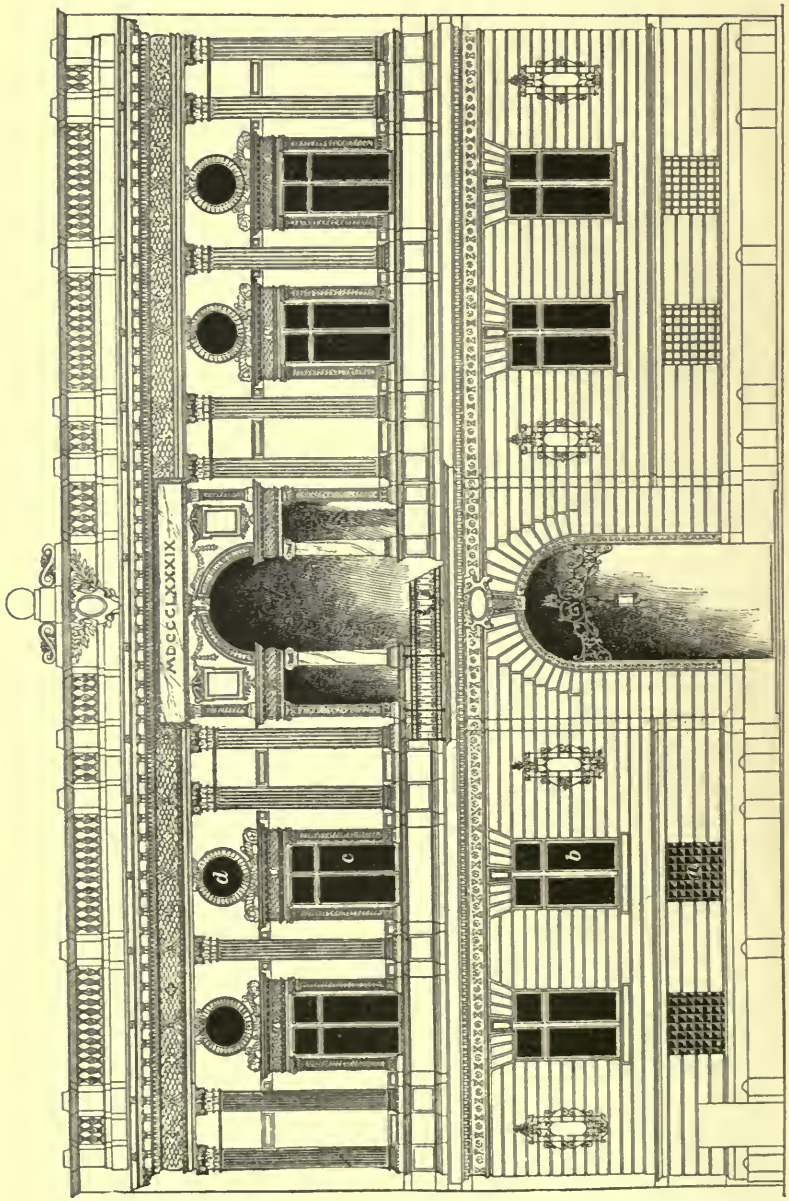


FIG. 84.

stories in height, and the requirements of the problem in design were that two of these four stories should have no prominence. In the first, or basement, story are located the business offices, coat room, lavatory, and other minor apartments, which were undesirable to express in the elevation, and which are lighted through the barred windows *a*. The second story, containing the reading room, smoking room, parlors, etc., is brought into prominence on the elevation and is lighted through the windows *b*; while the dining room and the library, occupying opposite ends of the third floor, receive their illumination through the windows *c*, and the circular windows at *d* admit light to the kitchen and servants' hall, which occupy one-half of the top floor, the other half being occupied by a gallery around the library. Thus, the second and third floors of the building are the only ones in which the visitor has any interest, and are consequently the only ones expressed in the elevation.

60. In the small private dwelling, where we require a less monumental design, the Italian Renaissance style is not so desirable, and more satisfactory results may be obtained by a Romanesque treatment, as the character of this style possesses the dignity of the classic, from which it grew, but at the same time expresses the economy of the Gothic, into which it merged, and is, therefore, more appropriate to the less pretentious dwelling. In other words, the Roman Renaissance is an appropriate dress for the monumental rooms of a mansion, while the Romanesque style is better suited to a residence where the privacy of home life is more conspicuous than the routine formalities of society. There are exceptions to this, however, in certain classes of work, which will be pointed out hereafter.

FRENCH RENAISSANCE.

61. In France, the influence of the old feudal system can be traced in the plans and arrangements of the residence architecture even down to the present day. The house of

Jacques Cœur, as shown in Fig. 86, *History of Architecture*, possessed a large interior courtyard, which had for its prototype the inner bailey of the feudal castle, and is considered such an indispensable feature of the modern dwelling, that it is found today in connection with all French mansions, whether of ancient or modern design. Modern French residences are built mostly in the Gothic or Renaissance styles,

FIG. 85.

the favorite appearing to be that period of Gothic which immediately preceded the introduction of the Renaissance, and that period of Renaissance which immediately succeeded or combined itself with the feudal Gothic—in other words, the style of architecture which prevailed during the reigns of Louis XII and Francis I. This style is particularly

adaptable to city residences, and affords great opportunities for elaborate carving and exterior decoration.

In the rural districts, and even in the less aristocratic streets of Paris, timber-frame fronts, such as is shown in Fig. 85, are very frequent, and represent a style of dwelling much imitated in modern rural architecture. These buildings were frequently constructed of stone up to the second or third story, as shown at *a*, and then framed with heavy timbers one, two, and sometimes even three stories higher. Between the members of this timber framing, a filling of brick or rough plaster work was inserted, giving the structure a most picturesque appearance, and at the same time conforming with one of the strongest characteristics of the Gothic style; namely, *exposed construction.* In Fig. 85 every framing timber of the front of the house is exposed to view, and the necessity of the existence and position of each is apparent at once. With the advent of the Renaissance, the vertical members of this framing were often possessed of a capital and base, thus forming a series of pilasters; and though they lost thereby much of their structural significance, they enhanced the picturesque effect very considerably.

62. The great châteaux, or private mansions, of France, built during the early part of the Renaissance period, still adhered more or less to the ancient castellar form, even when erected in the cities. Fig. 86 shows the plan of the Château de Bury, near Blois, erected about the middle of the sixteenth century, and is typical of the general arrangement of the luxurious French mansion of that time.

Each corner of the building is guarded by a tower *a*, 25 feet in diameter, relics of the feudal, while two smaller towers *b* flank the porte cochère, or carriage entrance *c*. The walls *m*, connecting the towers *b* with those on the corners at *a*, enclose a large courtyard *e*, around which are arranged the apartments of the dwelling. On the opposite side of the court, at *f*, are the family apartments, with the principal rooms facing on the court, while at *h* are the servants' rooms and apartments, opposite the stables and offices

at *g*. In the rear of the main building *f* is a garden *k*, with a chapel *i* at the back. The wings *g* and *h* are generally one story lower than the main building *f*, but the angle towers, which are nearly always round outside and square inside, are usually carried up to the same height. There is no essential difference in the general scheme of this arrangement and that

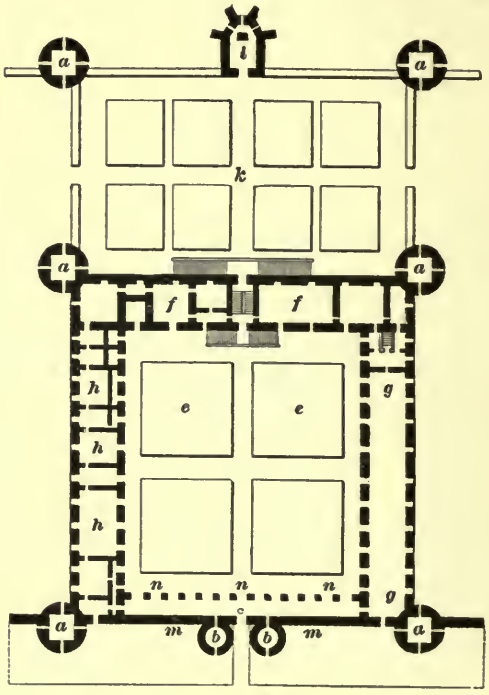


FIG. 86.

of the Château de Blois, Fig. 100, *History of Architecture;* but the rectangular outline of the plan, as contrasted with the irregular shape at Blois, is more in harmony with the exigencies of modern work.

Windows usually faced the garden and the court fronts, but none of the openings in the family apartments ever faced on the street, even when that wing of the house was built on the street front. The main front wall was never pierced by openings of any kind, except at the towers and porte cochère.

Behind it was a row of columns connected by arches, as at *n*, *n*, forming a covered arcade from the servants' wing *h* to the stables *g*. The towers were covered with a conical roof, and the parapet wall was sometimes castellated, and projected from the main wall on corbels, as shown in the old Château of St. Agil, Fig. 97, *History of Architecture*. The central part of the structure, containing the entrance door, was carried up a story higher than the towers, in order to give it emphasis, and was finished with a pyramidal or tent-like roof, from which this feature of the building derived its name of *central pavilion*—a prominent feature of the Louvre Palace, Fig. 127, *History of Architecture*. The dormer-windows in the upper story were usually finished with gables having concave sides and flat crowns, and flanked on the sides with pilasters. This style of gabled dormer is characteristic of the early French Renaissance, and may be seen in varied forms on nearly every château of this period.

The pilasters were repeated at the sides of the window openings in each story below, and their bases rested upon sill-courses, while their Corinthian capitals supported light string-courses, similar to the style of treatment in the Château de Blois, wing of Francis I, Fig. 103, *History of Architecture*. The walls were thus divided into a number of panels, each of which, in the second story, was decorated with a carved device representing a heraldic shield with a grouping of military weapons.

The basement wall was of rock-faced masonry battering on the exterior and plumb inside, while its window openings were small and devoid of ornament.

The cornice of the towers was battlemented—clearly an heirloom from the feudal castle, and used here simply as a symbolic detail. The towers also suggest the feudal period, and the only architectural forms which are novel to the structure are the Corinthian pilastered windows, and the regular, symmetrical, and systematic arrangement and balance of the details.

This type of the French mansion of four centuries ago is

also the type of the French mansion of today; the only difference being that in crowded cities, like Paris, Marseilles, etc., the street front is usually occupied by stores, and the towers are either omitted in front, or are corbeled out above the first story, to avoid taking up the sidewalk space.

63. A peculiar feature of the structures of the Renaissance period was the symmetry of the plans. Nearly all buildings were perfectly rectangular, and were divided into equal wings and other subdivisions. Compare the plans of Fig. 87 of the Elizabethan period, and Fig. 86 of the Francis I period, with the wild, irregular outlines of the medieval castle in Figs. 84 and 85, *History of Architecture*, and while we can see a strong resemblance in the combination and arrangement of the parts, yet they are reduced and curbed to a foreign rule in the Renaissance work, while in the Gothic they are as free and untrammeled as the hills on which they stood. This point should be borne in mind when planning at the present day. If the design is for a mountain cottage, hotel, or sanitarium, let the outlines of its plan be as free as the land on which it is erected; but remember that, while a little natural irregularity is pleasing, too much of it offends good taste. Irregularity of plan should appear natural, as resulting from the surrounding conditions, and not studied or forced, as though to produce oddity of effect.

Many a building erected on a hilltop or hillside has been spoiled in its architectural effect by having received too much attention in the endeavor to render its lines symmetrical, instead of a proper amount of study towards fitting it to the contour of the ground it was to occupy. Gothic architecture is true and undeceiving; it boldly exhibits every detail of its own construction, and makes no efforts to hide the causes which necessitate irregularities of its plan. The Renaissance style, on the contrary, conceals its construction, or else makes great pretensions of constructive features, which examination will show to be but surface imitation. It may be beautiful, as in many instances it is, but it cannot be considered permanent, or even rational, building.

GERMAN RENAISSANCE.

64. Owing to the scarcity of stone in Germany and Switzerland, we see more timber construction than masonry adopted for buildings, especially in the rural districts.

In the larger cities there are many handsome and pretentious residences, but in general character they lack purity of style, and can hardly be recommended as a type for the domestic structure of today. In the German Gothic style, the roof was large and very pointed, and frequently enclosed more stories than the walls below it. This was due to the fact that it was used as a drying room for laundry purposes, the large number of windows being necessary for the free circulation of air. The timber construction was expressed on the exterior of the buildings in the same manner as in the French work, but in many instances the floor timbers projected beyond the face of the building at each successive story, and the walls being erected on the extremities of these beams caused the house to be of larger dimensions at the top than at the foundation line.

Feudal castles existed throughout Germany as in France. Many of the finer mansions in the cities show their evolution from these medieval fortresses, and the castles on the Rhine stand today monuments of Germany's once great feudal strength; but in the Renaissance period the details for stone are contaminated with those of the timber construction, and it is no unusual thing to see a light, timber upper story, built upon a three or four story substructure of massive Gothic stonework, without any apparent reason for the combination.

ENGLISH RENAISSANCE.

65. In Great Britain, the Gothic style has prevailed for all kinds of domestic architecture, and, like that of France, the favorite period appears to be the one when Renaissance art was first working its influence over Gothic forms. In England this is known as the Elizabethan period, and during

its time the most comfortable adjuncts of the private residence were developed.

The Elizabethan period is also remarkable for the number of educational institutions that were erected, and this style of architecture, therefore, is most appropriately used in the designing of schoolhouses, colleges, etc. It was never originally used as church architecture, no large churches having been erected during the time of its development, but in some modern instances Presbyterian churches have been erected in the Elizabethan Gothic style, as Presbyterianism was established during the reign of the queen from whom this style takes its name.

66. The chief characteristic of the Elizabethan plan is the large, open hall *a*, Fig. 87—a legacy of Gothic times—

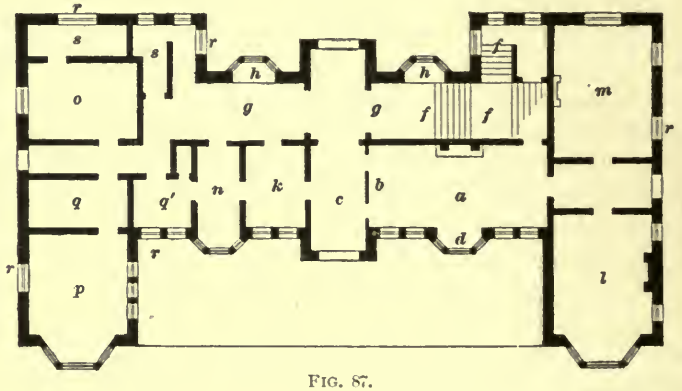


FIG. 87.

which was paneled in oak to a height of 8 or 10 feet above the floor, as shown at *a*, Fig. 88. Above this paneled wainscot were arranged trophies of the chase, portraits and armor of ancestors, pieces of tapestry, and various other relics and heirlooms, as shown at *c*, Fig. 88. At the end of this hall was a carved oak screen *b*, Fig. 87, separating it from the entrance hall *c*, over which was the music or minstrels' gallery, a feature which is also a relic of Gothic days. A large bay window *d*, Fig. 87, the sill of which reached nearly to the floor, was a prominent feature of the center of the side of the hall,

or often of the end, as at *b*, Fig. 88. The fireplace was very elaborate and was usually carved with the owner's crest or coat of arms, and other heraldic devices, as shown at *d*, Fig. 88. The ceiling of the hall was usually of open timber construction, as at *e*, in which the girders and floorbeams of the story above were exposed; or, when this part of the building was but one story high, the roof was of open construction, and frequently was elaborately carved. Next to the hall *a*, and entered from the entrance hall *c*, Fig. 87, was the great gallery *g*, extending nearly the entire length of the

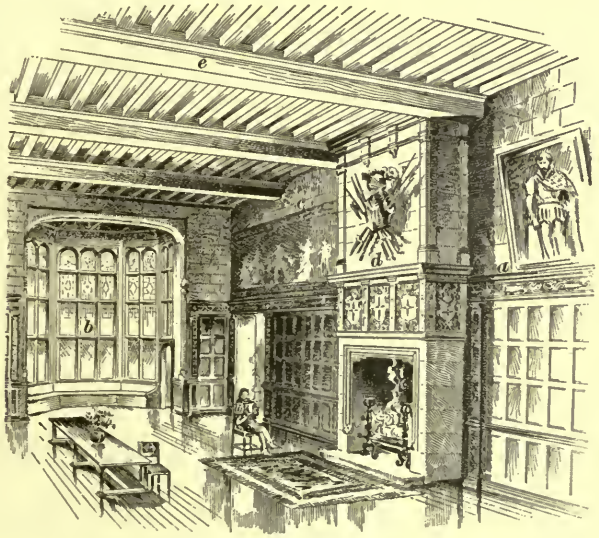


FIG. 88.

house, and one of the most characteristic features of the Elizabethan style. This gallery is very low and narrow in comparison to its length, but is relieved by immense bay windows *h*, which are often as large as an ordinary room. At the end of the hall was another prominent feature, the broad staircase *f*, the newels of which were richly carved, and the balustrade, instead of being a series of balusters, was generally an oak parapet pierced by numerous geometric forms, as shown in Fig. 73. Other rooms in the plan are the family dining room *k*, the state dining room *l* (a distinction now

modernized by the use of the terms breakfast room and dining room); the drawing room is shown at *m*, and the smoking room at *n*. The kitchen is shown at *o*, and the servants' hall at *p*, while pantries were located at *q* and *q'*, and at *s* were the storerooms.

The windows *r* were large and numerous, but were subdivided by many mullions, while the glass was cut into small panes and was separated by strips of lead, as may be seen at *b*, Fig. 88. The bay windows were large and extended through several stories.

67. The gables of the Elizabethan house were irregular in outline, with alternating concave and convex quadrants of circles, as shown at *a*, Fig. 89, and were sometimes pierced

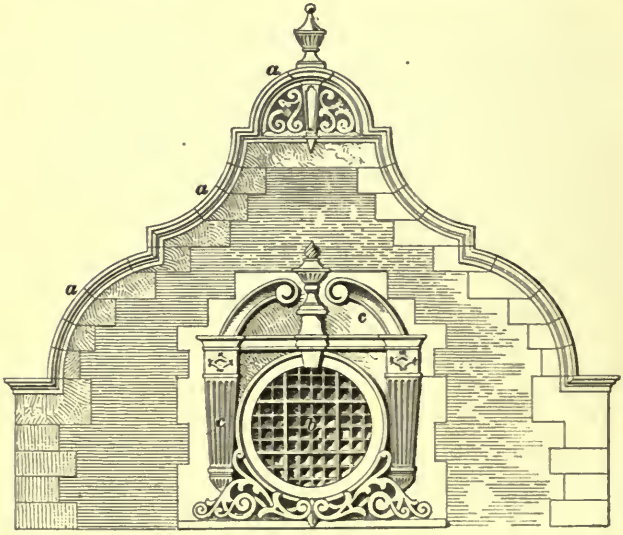


FIG. 89.

by a circular window *b*, or ornamented with a cartouche or other carved device, as shown at *c*.

This style of gable was probably borrowed from Holland, for, though common in many Elizabethan houses, it is decidedly a Flemish detail. England was on very friendly terms

with Holland at this period, the Flemish people having even offered the sovereignty of their country to Elizabeth, and it is not to be wondered at if details of Flemish architecture were popular in English art. This alternating convex and concave outline of gable is as characteristic of the Elizabethan period as the gable described in Art. **62** is of the period of Francis I.

68. Wooden architecture prevailed in the rural districts of England even more than in France, and after the Elizabethan period it was more debased in style than the more

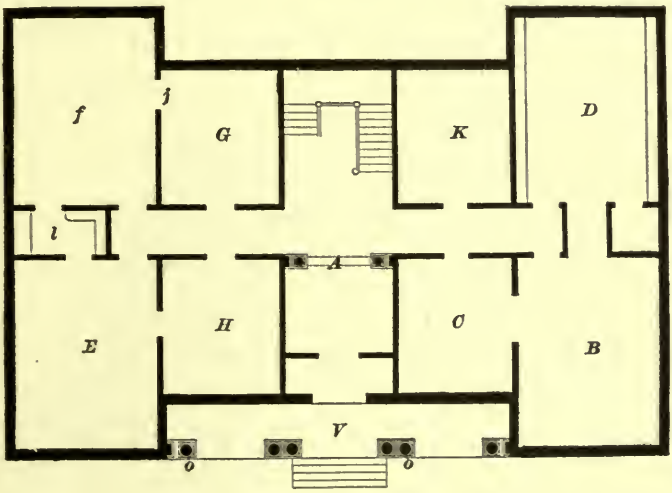


FIG. 90.

pretentious erections in stone and brick. During the period of the Classic Revival, the plans of the English dwellings lost all resemblance to the arrangements of the early Gothic days, and the houses were planned by crowding into a rectangle whatever rooms and apartments were required by the owner. The grand hall of Gothic days, the Elizabethan gallery, and the rambling, irregular passageways of the old English manor house, all disappear; and in their stead we have a rectangular plan, Fig. 90, with a wide hall *A* containing the stairs, and running through the center of the house from front to rear. The space on each side of this

hall is divided into symmetrical and rectangular rooms, of which *B* is the drawing room, *C* is the parlor or reception room, and *D* is the library. The room *K* was sometimes designed as a smoking room, and often as a study connecting with the library *D*. The kitchen was at *f* and communicated with the dining room *E* through the pantry *l*, and with the servants' hall *G* through the doorway *j*. The room at *H* is the breakfast room or family dining room.

On the exterior, these houses had immense columns *o* extending through two stories, and supporting the portion of the roof which projected over the long porch, or veranda *V*. Or, in some cases, these columns were but one story in height, and the second story was carried out over the veranda and supported on them; or sometimes they carried an upper balcony over the porch *V*.

EARLY AMERICAN RESIDENCE ARCHITECTURE.

69. To understand the style of domestic architecture most generally adopted in the United States, a more thorough consideration of the circumstances which led up to its formation must be considered. Unlike the homes and residences that were, in Europe, developed from a progressive alteration and improvement of the early fortified domicile, the houses in America were in the first instances most primitive, and were simple huts erected to protect the settler from the inclemency of the weather. Subsequently, as the colonies prospered and a feeling of permanency came over the colonists, a longing for the details of the European home caused the transplanting of the style prevailing in the mother country at the time of the American colonization.

The northeastern part of the Atlantic coast was settled in the early part of the seventeenth century by a colony of English Puritans, who came to America to avoid the persecutions which were practised under the English laws. Their residences were as close an imitation of their English homes as the materials at hand and the skill of their artisans could

build, and their religious views being opposed to the amassing of wealth or living in luxury, their domestic arrangements were of the simplest kind.

However, the country was wild, and the dense, unbroken forests concealed unfriendly tribes of Indians that were liable to swarm into a new settlement and massacre the inhabitants without the slightest warning; so that nearly every village required at least one dwelling which should be of a more or less military character, to serve as a rallying point for the townspeople, where they could more effectually repel such onslaughts. One of these military residences, the old brick house of Governor Cradock, as shown in Fig. 91, was built

FIG. 91.

in 1634, and is still standing. Simplicity marks the design; no use was made of the orders as in the prevailing revival period in England; it is simply a strong, brick, rectangular structure, with a few small windows and a massive iron-bound door that defied the attacks of the stone tomahawks of the Indians. The timber with which this house was built was hewn within a few feet of the site, and the bricks were burned on the premises. Iron guards were built into the doorway, and four suggestive loopholes *a* showed it was a military house from necessity, and a residence and trading post from choice. The other houses were of frame, or, in

earliest times, of simply rough-hewn logs piled up like a cabin and shingled on the outside with hand-split shingles, which were secured in place with hand-forged nails. After the middle of the eighteenth century, many of the descendants of these first settlers, by dint of hard work and close trading, had, in spite of their religious sentiments, become very rich, and with their riches came the desire for splendor and luxury.

70. Nothing would be more natural than to turn to the mother country for ideas in architecture, especially as all the mechanics in the colony were men who had either learned their trades in Europe, or were the sons or apprentices of men who knew no other art than that evidenced in their English homes.

Hence, we see long two-story pilasters attached to the exterior angles of the house, supporting a heavy classic cor-

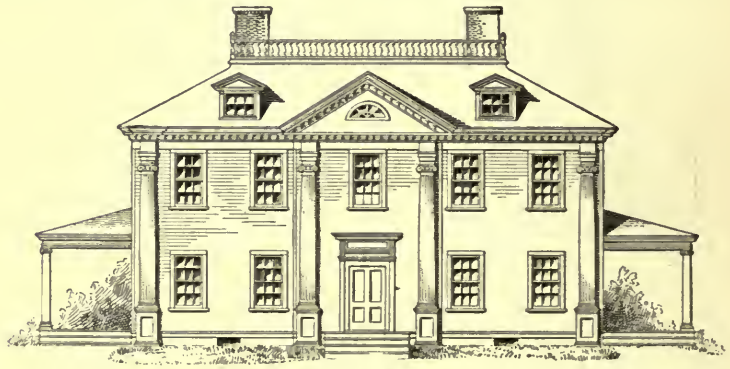


FIG. 92.

nice and often a rich pediment with dentils and modillions, all of which were built of wood. Such was the Cragie House shown in Fig. 92, and also in Fig. 131, *History of Architecture*, built in 1759, at Cambridge, Mass., still standing, and, from 1837 to the time of his death, the home of the poet Longfellow. Here we see the symmetrical facade, the two-story pilasters, and the heavy, steep pediment so characteristic of the Classic Revival period in England; and,

though singularly inappropriate in the American wilderness, these were details so popular that no important residence of the period was considered complete without them.

71. If we now turn to the southern colonies of the United States, which were also of English origin, a very different condition of affairs presents itself to us. The early settlers of this region, who were of aristocratic birth, came to America principally for commercial interests, and their religion, being that of the Church of England, interfered in no way with any desire of amassing wealth or property. They bought slaves and employed them in raising tobacco, the staple product. Essentially a countryman by preference, each of these early settlers loved above all things the comparative solitude of his great country home, with its dependent village of servants, farm hands, and mechanics, its stables filled with English horses, its barns filled with high-bred cattle, and its flourishing fields of tobacco and grain. The roads in this part of the country were mere bridle paths, as travel by any wheeled vehicle was almost unknown, and the negro slaves did all the work of harvesting the grain and tobacco, while the settler sat in the shade of his porch and watched them. Merchants and other tradesmen were, by these landed gentry, referred to as mere peddlers, and mechanics and artisans were scornfully called tinkers, as all commerce and trade was considered unbefitting a gentleman's calling.

The soil was very fertile, so that the planters were soon able to indulge in lavish hospitality, and leave to their servants and slaves the entire cultivation and disposition of the immense tobacco crop. Many of these settlers were the sons of prominent English noblemen, so that from the beginning of their existence the southern colonists possessed much taste and refinement, and as their hardships were few compared with the New England settlers, they could immediately turn their attention to the erection of comfortable dwellings, replete with those adjuncts of a luxurious and comparatively idle life which the possession of slaves enabled them to live. Thus, the gentry of Virginia were the first to introduce glass

in their windows, while their New England cousins kept out the cold and admitted light through pieces of isinglass, bone, or bladder. The southern colonial houses were comfortable and substantial from the first, and the inherited desire for dignity and splendor is manifest in the Virginian settler's preference for a brick dwelling, in a country where wood was the most natural material and was everywhere abundant.

72. The style of these houses was a brick imitation of the early part of the Classic Revival in England. Plain brick walls with square-headed openings formed the block design of the structure, and this was frequently relieved of monotony by stone quoins on the corners and stone lintels over the windows, or a heavy wooden cornice with a wide pediment was carried across the top and was apparently supported by the heavy wooden pilasters which extended through two stories. The entrance was very prominent, being frequently a four-columned portico, and it usually opened into a large square hall, which, with its polished hardwood floor and generous open fireplace, gave an air of hospitality to the house, excelled in no other style.

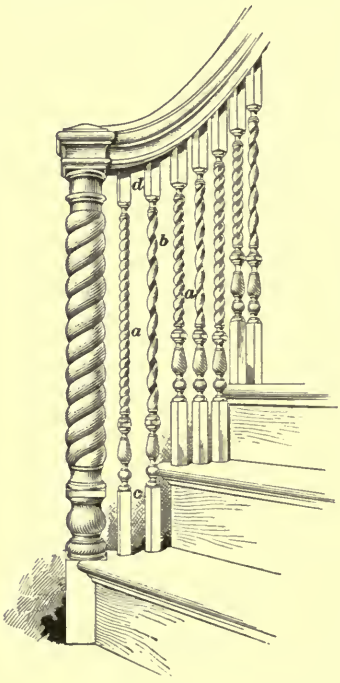


FIG. 93.

Prominent in this hall was the staircase with a plain mahogany hand rail and white enameled balusters and steps. These balusters were very slender and could with more propriety be called spindles, while their form and design took every style and phase that the mind of the designer could devise. In New England the

first hand rails were perfectly round, of any kind of wood that came handy, and the balusters were usually rectangular in section, about $\frac{3}{4}$ in. $\times 1$ in. In Virginia, the hand rail was round on top, flat on the bottom, and hollow on the sides, worked from a selected piece of solid mahogany or rosewood, the balusters being turned in the form of a twisted rope, as at *a*, Fig. 93, or as a spiral spring, as shown at *b*, or having the appearance of an attenuated column; they always had a square prismatic section. *c* at the bottom, and a similar section at the top, as at *d*. Two or more different designs of balusters *a* and *b* were often used in the same flight.

73. Before either of the foregoing colonial districts were established, New York state had been settled by the Dutch, and was called New Netherlands. It passed into the hands of the English in 1664, just fifty years after it was founded, but the Dutch had impressed so many of their characteristics upon the architecture, that for a number of years it did not entirely get rid of them, but at last the English elements prevailed, though in some parts of the state it was hardly felt at all.

The style of house erected in Massachusetts and in Virginia did not suit the Dutch settler at all. A long, low house, with the roof coming down to the top of the first story, and with one or two stories above, entirely under the slope, was much more to his liking. The phlegmatic Dutchman looked upon long flights of stairs as a nuisance, and his ceilings were high enough if they were nine feet above the floor, and there was no use of a second story if an attic would do just as well; his house, therefore, tended more to horizontal dimensions than to variations in height. Very little variety is encountered in houses of this period, and the only characteristic which remained to influence the architecture of later times was the stepped gable, which, though it occurred sporadically in New England, was here seen at every turn from the Hudson River in New York to the Susquehanna River in Pennsylvania. Towards the close of the eighteenth

century the settlers, still retaining some of the Dutch details, began to lean towards the classic forms.

74. The system used by the Dutch government in Holland to colonize its American possessions, had marked influence on the architecture of this period. This government issued a charter to a company which was organized for the establishment of colonies in America. To any member of this company who would take or send fifty settlers to America within four years, this charter gave a tract of land extending 16 miles on one bank of a navigable river, or 8 miles on both banks of the river, and reaching back as far inland as he could occupy to advantage. The member received the honorary title of *Patroon*, and in return he agreed with his government to pay the expenses of the emigrant's passage from Holland, to stock a farm for him with horses, cattle, and agricultural implements, at small rent, and to provide a schoolmaster and minister of the Gospel. The settler in return made certain advantageous agreements with the patroon. In the vicinity of Albany, N. Y., a patroon named Van Rensselaer thus secured an estate of over seven hundred thousand acres. It extended on both banks of the river for a distance of 24 miles, and nearly twice that distance back, and additions were subsequently made, until the area of this vast domain exceeded that of the state of Rhode Island. Such a proprietor was richer than many a German prince. He was at once owner, ruler, and judge, and had not only a population of white settlers who were his servants and laborers, but also the promise of as many negro slaves as could be provided by the chartered company of which he was a member.

Thus, Killian Van Rensselaer, the first patroon, left to his posterity an immense estate, on which they built in 1765 to 1790 three magnificent manor houses, designed to equal, if not exceed, anything the colonies possessed. The resulting structures, two at Albany and one at Greenbush, near Albany, were classic in design, but influenced even at this late day by many Dutch details, both of interior arrangement

and exterior treatment. One of these details was the dormer-windows on the Albany manor, which, though flanked by pilasters and crowned by a pediment, bore a strong resemblance to the typical Dutch New York City dormer, shown in Fig. 94. The roof of the Greenbush house was of the gambrel form so prevalent in Massachusetts, and the last one of the three, built in Albany in 1790, has a Palladian window, treated with an arch and two square-headed openings, similar to Fig. 34 of *Architectural Design*, § 21, over the entrance, and a denticular cornice supporting a railing or latticed balustrade around the roof, suggestive of the style used in Maryland and Virginia.

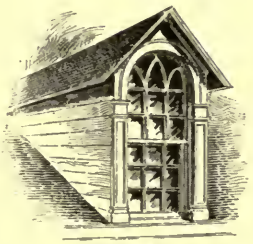


FIG. 94.

75. At the beginning of the present century, colonial architecture in the Middle and Eastern states had evolved into a combination of nearly all the early styles of building existing in America from the beginning of its settlement in the seventeenth century. In the Southern states, however, the style was influenced by foreign elements brought in as a result of the War of the Revolution.

In the year 1778, the king of France, Louis XVI, recognized the independence of the American colonists, and agreed to help them with both men and money in their war with England. This promise the French government fulfilled, and, as a result, the French people became very popular, and French forms, furniture, and details were introduced in many buildings repaired or rebuilt after the war.

After the assistance sent by France was received and the French forms and ideas became so popular in the country, the war became centered more in the southern part of the country, and the effect of this French influence is noticeable more particularly in southern colonial architecture; but, after the war was over, and the colonies became united into one country, the styles of the North and the South became

intermingled, and architecture throughout the country became more uniform and systematic.

76. American architecture was then mostly a wooden imitation of classic forms, and the coloring was in nearly every instance pure white. Inside woodwork was painted several coats of white paint, each one of which was allowed to dry and was then thoroughly sandpapered, until the resulting finish was so smooth and white that it received the name of *ivory enamel.*

Though the general style of this period was the same throughout the country, there was an essential difference in the general planning between the houses of the North and those of the South.

77. Fig. 95 is the plan of a southern colonial house, of the type that prevailed in Maryland and Virginia, and is an American modification of the Elizabethan home its builder

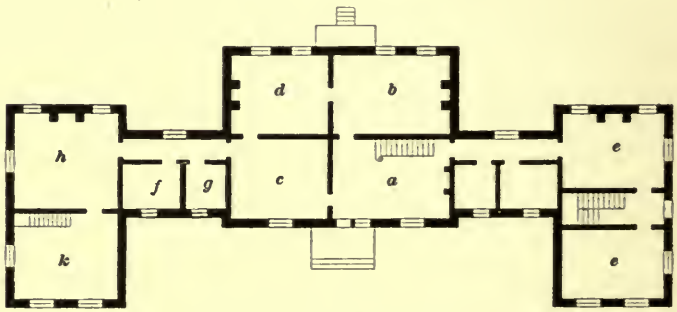


FIG. 95.

had left when he emigrated to the colony. Compare it with the plan in Fig. 87, and we see that if we remove the great gallery *g* from the Elizabethan plan, we shall have, in outline at least, a strong resemblance to Fig. 95. Let us analyze the interior arrangements in detail, and see how much further the similarity can be traced. The great hall *a*, the entrance hall *c*, and the gallery *g*, in Fig. 87, we find combined in the large entrance and stair hall *a*, Fig. 95. The colonial

dining room *c* corresponds very closely in its location to the small Elizabethan dining room *k*, and though the parlor *b* and the library *d*, Fig. 95, are located in a position far remote from the similar apartments *l* and *m* in Fig. 87, this is easily accounted for when we take into consideration the difference of customs in the two countries. In the American plan, we have two rooms *e* which were used as reception rooms for guests and sitting rooms for the family, which are similarly located to the drawing room *l* and the state dining room *m* in Fig. 87, and again we see the kitchen *h*, the laundry *k*, the pantry *f*, and the storeroom *g*, all located in the same wing of the house in Fig. 95, as are similar servants' quarters in Fig. 87.

78. Fig. 96 is the plan of a house of the type that prevailed in the Northern states, and is clearly an offspring of the English arrangement shown in Fig. 90. The parlor *a*, library *b*, sitting room *c*, pantry *d*, kitchen *e*, and dining

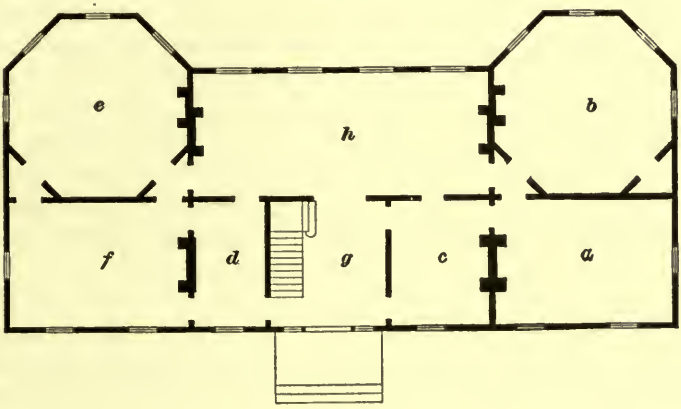


FIG. 96.

room *f*, in Fig. 96, are almost identical in their location with similar apartments in Fig. 90, the only strong difference appearing in the elimination of the servants' hall *g* and smoking room *k* of the English plan, and the moving of the

stair hall to the front of the house, thus converting the entire space occupied by these rooms in Fig. 90 into a grand reception hall *h*, Fig. 96. This reception hall was a characteristic of the American colonial residence. In this room, with its immense fireplace at each end, were held the formal state dinners which every man of prominence considered it his duty to give, at least once a year. Here, also, the figures of the stately minuet were executed with that military precision and graceful formality which so marked the manners of colonial days; the Christmas dances, the New-Year receptions, and the Twelfth-Night festivities, all took place in this immense reception hall of the typical New England home.

This hall *h*, opening, as it does, out of the paneled entrance hall *g*, and communicating with the parlor or withdrawing room *a* on one end and with the dining room *f* on the other, is traceable back through the Elizabethan period in England, even to the feudal ages, where the principal room of the castle was the great Gothic hall, which, as we have already seen, was afterwards separated into three apartments, the withdrawing room, the dining room, and the hall—precisely the arrangement we have in Fig. 96. In the earliest American homes, this reception hall served as parlor, dining room, and living room or reception room alike, and it is only after the beginning of the eighteenth century that we find the separation shown in Fig. 96. A singular parallel in circumstances makes this form remarkably appropriate when we consider it from a strictly architectural standpoint. The feudal lords of Great Britain and France built and fortified castles from which to defend their estates against invasion, while, in times of peace, their vassals tilled the soil and paid immense taxes or rents to the feudal landowner for the privilege. In the northern colonies, the Dutch patroon received taxes from immense tracts of land on which he had established a number of farming colonists, who were his vassals just as surely as were the wine growers and farmers of the thirteenth century; or, as in the South, the English landowner received the benefits and amassed wealth through

the labors of his negro slaves, whom he considered his personal property just as much as he did his horses or cattle.

In each of the colonies there was at least one strong and partly fortified residence to which the inhabitants could flee and defend themselves at the time of an Indian outbreak. So we have very nearly the same governing influences in American colonies, at the close of the seventeenth century, that existed in Europe four centuries previous, with one great exception: the American colonists were laying their plans for peace and contentment, but the feudal lord fortified his castle for war and aggrandizement. As a result of this, the American manor is hospitable and open to all who come in peace, while the early Gothic dwelling was entered between turreted portals which frowned with suspicion and forbiddance on both friend and foe.

Thus we see the number and variety of elements which must be considered in laying out the design of a private house, which, as has already been said, is a problem to be solved in exactly the same manner, whether the house be the cottage of the frugal mechanic, or the palace of the merchant prince. The rooms of the plan are arranged to suit the convenience of the family that is to live in them, and the design of the details is executed to express the purpose for which the structure is built, and the period in history with which the arrangement of the plan or the tastes of the family are most nearly in accord.

RELATION AND PROPORTION OF ROOMS.

79. Of course, the question of cost exercises a material influence upon the elaboration of the plan of a building, especially in private-residence work, and the architect must be familiar with the cost of labor and materials in different localities, in order not to exceed the limit of expenditure placed at his disposal. In designing a private residence, a

country home, a hotel, or a dwelling of any kind, the architect must study his client's tastes and mold the plan of the building in harmony with the individuality and disposition of the owner. A well planned house is perfectly adapted to the needs of the family for whom it is designed, and for no other. We may, indeed, liken a man's house to his coat, in this respect: that the more perfectly it fits its owner, the less likely it is to fit any other person. A perfectly designed house, therefore, whether consisting of one room or one hundred, will be so arranged as to provide for its occupants the greatest amount of convenience and comfort possible under given limitations, and so far as a design fails in doing this, it fails of being a success. This result is to be obtained only by following the general rules which govern the planning of the various rooms of which private houses are composed, and by studying the various individual wants of those who are to occupy them.

If we submit the plan of a house to a careful analysis, and discuss each feature of its arrangement with regard to its relation to the other features, we can deduce certain rules, which should guide us in the effort to plan a building to suit certain prescribed requirements.

80. Every house plan is composed of two general divisions: the principal rooms, and the halls or passages for communication between them. The latter we distinguish from the rooms under the name of thoroughfares. The rooms are subject to a division into family rooms and servants' rooms, and each division may be subdivided into public family rooms and private family rooms, and public service rooms and private servants' rooms, on the principle that those rooms which are exclusively for the use of one or more members of the family are *private rooms*, and those which are for the use of the entire family are *public rooms*.

81. Arranging them in a tabulated form we have the following analysis of the private house:

- The House,
  - Rooms.
    - Family,
      - Public,
        - Drawing Room,
        - Parlor,
        - Reception Room,
        - Library,
        - Music Room,
        - Dining Room,
        - Breakfast Room,
        - Billiard Room,
        - Verandas.
      - Private,
        - Study,
        - Bedrooms,
        - Dressing Rooms,
        - Bathrooms,
        - Certain Verandas,
        - Balconies, Etc.
    - Servants',
      - Service,
        - Kitchen,
        - Pantries,
        - Laundry,
        - Storerooms, Etc.
      - Private,
        - Servants' Dining Room,
        - Bedrooms,
        - Bathrooms,
        - Servants' Verandas,
        - Etc.
  - Thoroughfares,
    - Family,
      - Public,
        - Principal Porches,
        - Vestibule,
        - Entrance Hall,
        - Inner Hall, Etc.
      - Private,
        - Family Stair Hall,
        - Family Corridors.
    - Servants',
      - Service,
        - All Hallways between Family and Service Rooms.
      - Private,
        - All Hallways between Servants' Rooms or Servants' and Service Rooms.

82. The Entrance.—One of the most important features of the exterior of the house is the entrance, as it is the one detail with which the outside public are most immediately concerned, and with regard to its position they should, therefore, be left in no doubt whatever. It should not only be placed in an easily accessible position, but it should in some way be emphasized as a part of the design, and the approach to it rendered so distinct that it would be impossible to mistake it for anything other than the main entrance to the house. Too often we see error committed in this respect by an excessive display of prominent features in the facade, such as towers, gables, bay windows, porches, etc., and the principal entrance, though it may be effectively treated, is not readily distinguished amid the abundance of detail. On the other hand, we frequently see the main entrance of a handsome dwelling treated in such an unobtrusive manner as to be hidden in the recess of a deep veranda, so that the house lacks the requisite expression of hospitality and welcome.

83. One feature of the entrance which often requires much consideration is the **porte cochère,** or carriage entrance. It generally consists of an addition to the main entrance of the house in the form of a roof-covered driveway, where visitors may pass from their carriages to the house without exposure to the weather. It is frequently designed simply as a projection of the veranda roof, the outside of which is supported upon two or more columns, as shown in Plate II, where *E* is a section taken through the building and shows the porte cochère at *l*. In size the porte cochère varies according to the pretensions of the house, but it should never be less than 8 feet wide by 16 feet long, and its height, though frequently governed by that of the veranda roof, must always be at least 12 feet in the clear.

84. The **dining room** illustrates the theory of the art of planning better than any other division of the house. It furnishes the key to the development of the entire structure, and by its location, dimensions, and proportions, it determines largely the size and location of many of the adjoining

rooms. A dining table should never be narrower than 3 feet, and is frequently 4 or $4\frac{1}{2}$, while in large houses the width of the table sometimes attains 5 or 6 feet.

Persons seated at the table require at least 16 inches from the edge of the table to the backs of their chairs, and where heavy armchairs are used, 20 inches is required; while a passageway from 2 feet 8 inches to 3 feet 6 inches in width should be provided between the backs of the chairs and the wall, for the use of the servants while attending the meal. Thus we have a minimum width for the dining room of 11 feet, but provision must be made for extra furniture, such as chairs, buffet, etc., and an additional width should be given to the room to permit their introduction.

A moderate allowance for each individual at the table is 2 feet 4 inches in width, and a simple rule for finding the length of a dining table required to seat a certain number of persons is to multiply 2 feet 4 inches by *one less than half the number of diners* to be accommodated. Thus, the length of a table required to seat twenty people would be $\frac{20}{2} - 1 = 9$, and 9×2 feet 4 inches $= 21$ feet. Now, if we leave at the back of the end chairs a space of 4 feet for service and furniture and an additional 1 foot 4 inches for the space occupied by the diners at the ends of the table, we would require a dining room 31 feet 8 inches long for a household of twenty.

85. A very desirable position in which to place the buffet is directly opposite or at right angles to the strongest light, as any other position will detract from the artistic effect that can be obtained through the judicious display of silver plate and cut glass. The principal light should be from the end rather than from the side of the room, for the reason than fewer of those seated at the table will have the light directly in their eyes, and the plates as well as the faces of those whose backs are to the light will be in shadow.

Care should be taken, however, where the room can be lighted from only one end, that the windows should not be grouped in the center, but should be separated and placed near the corners, as, in the former case, the concentrated

light causes every object in the room to cast a deep shadow. If possible, a second light on the side and towards the other end of the room should be introduced to obviate this difficulty.

Whether a dining room should communicate directly with any other of the rooms of the principal suite, is a question which can only be decided according to the circumstances in each particular case. It should always be so arranged as to be completely shut off from the rest of the house during the time of preparing and clearing off the table before and after meals. Sliding doors are very convenient for this purpose, especially in small houses, where it is desirable to throw all the principal rooms open on the occasion of an evening party.

In locating the dining room on the plan, it is desirable to avoid having it face the west. First, because the comfort of those seated around the table at the hour of the evening meal, would require the closing of all western window shades, in order to exclude the low level rays of the setting sun, and, second, such a room would be very cheerless to breakfast in on a winter morning. An exposure on the east or southeast side will, however, be warm and cheerful on winter mornings and cool and comfortable on hot summer evenings. The dining room, therefore, should be placed on the east or southeast side of the house unless there is a breakfast room in which to serve the morning meal, under which circumstances the aspect is of no great importance except that it should never face the west. The breakfast room is usually near to or adjoining the dining room, and in it breakfast and luncheon are usually served. It may depend upon the dining-room pantry for its service, or have a small pantry of its own communicating with the kitchen. In the latter case, it is not important that it should be near or next to the dining room, as it has its own base of supplies.

86. The relation of the dining room to the adjoining parts of the house, and the details of its communication with the *kitchen*, are of the utmost importance in the attainment of a well regulated plan. The route from the kitchen to the dining room through which the meals travel, must be

entirely separate and distinct from the family thoroughfares. Where the kitchen is in the basement, the arrangement is a simple one, as, the pantry being next the dining room, communication between it and the kitchen may be established by means of a dumb waiter.

This dumb waiter should not open directly into the dining room or the kitchen, but into a pantry at each end, whereby the odors and noises from the kitchen may be prevented from traveling up the shaft into the dining room.

Where the kitchen and dining room are on the same floor, the problem of arranging this service route becomes more complex, and often requires careful study and attention.

On no condition should the kitchen be permitted to open directly into the dining room. A pantry should intervene between the two, and the doors from the kitchen to the pantry and from the pantry to the dining room should not be placed opposite each other, as this would insure a view of the kitchen from the dining room every time both doors were left open. It is very desirable that the kitchen should not abut directly on the dining-room wall, and where it is not convenient to design a corridor between them, a row of closets or a back stairway may be made to serve the purpose of an insulator against the transmission of noise. The pantry should be of such dimensions as will permit the introduction of a sink, table, dish and napery cabinets, together with a dumb waiter, in houses where the kitchen is located in the basement.

Where the pantry is on the same floor and next to the kitchen, there should be a small window in addition to the regular door opening between them, in order that the service of the meal can be effected through this window from the kitchen to the pantry and from there to the family or guests at the table.

The sink in the pantry is generally of porcelain or of iron lined with porcelain, and has a wood drip board at one or both ends, on which the dishes are so placed that the water may be drained from them after they are washed.

All the fine dining-room china and glassware are washed at the pantry sink, and are stored in the pantry dresser or closet.

A review of all the facts in the case heretofore set forth seems to justify the following rules to be observed in planning the dining room:

1. *If used as a breakfast room, the exposure should be easterly or southeasterly.*

2. *It must always have easy and convenient communication with the kitchen, but under no circumstances should the communication be direct.*

3. *It should be situated, if possible, not directly on the entrance thoroughfare, but upon the private family thoroughfare near its junction with the public family thoroughfare.*

4. *Except with the breakfast room (or, in small houses, the parlor), the dining room should have no direct connection with any room of the public suite, and where it opens into an entrance hall it should have another and more private entrance from the private family thoroughfare.*

87. The **drawing room** and **parlor** are, as we have found with the dining room, governed in position, shape, and size entirely by the purpose they have to serve.

The essential difference between these rooms lies entirely in the character of the dwelling in which they exist. The parlor is generally a family sitting room, and, as stated, may open into the dining room in order to throw open the house for an evening party. The drawing room is found only in large and pretentious houses, and is used almost exclusively for the entertainment of visitors on the occasion of formal calls or evening parties.

In small houses, where the two principal rooms on the ground floor are the parlor and dining room, the former is used by the family on all occasions, both morning and evening. In more elaborate dwellings, these rooms are reserved almost entirely for formal receptions and dinners, while the breakfast room and sitting room (sometimes called the morning room) are reserved for the use of the family.

Where the parlor is scarcely more than a family sitting room, its shape is of no particular importance, but it is

always more desirable to have the length greater than the width, as an oblong plan is susceptible of better decorative treatment in furnishing, and if the outline is broken by a bay window or a corner tower, the interior effect is still more pleasing. The windows should be grouped to leave plenty of wall space for pictures, and the same recommendation as to lighting the glass and silverware in the dining room will apply to the pictures in the parlor. Avoid the grouping of windows on one side of the room, and never restrict the entrance to a single door opening from the hall. A liberal opening, having sliding doors where practicable, should open from the parlor into at least one of the adjoining rooms, in order to relieve it of that box-like appearance so undesirable in small country houses.

88. The drawing room should be adjacent to the main public thoroughfare, with which it should communicate by folding or sliding doors, or still better through a wide opening closed by a *portière*, or door curtain. It should also communicate with such other rooms as circumstances may dictate, but preferably with the morning room or music room, if there be such in the house. In the absence of either of these last named, the drawing room may communicate with the library by sliding doors over which are hung a pair of heavy portières, which will serve the double purpose of relieving the student in the library from the distracting influence of conversation in the drawing room, and of taking away from the drawing room the inhospitable appearance of tightly closed doors.

As to shape, the drawing room should be oblong rather than square, as by that form it tends to break up the company into smaller and more congenial groups, instead of massing them into one unmanageable body, which a square room is almost sure to do. For this same reason, irregularity of plan is highly desirable, and the judicious introduction of bay windows and alcoves will add much, not only to the beauty of the room, but also to the success of the entertainments held in it. Careful study should be given to the

location of, and aspect from, the drawing-room windows, placing them where they command the finest views, and at the same time spacing them so as to divide up the wall space judiciously for the hanging of pictures. At least one window should look towards the west, as the low, red rays of the setting sun add materially to the beauty of a well decorated room.

89. Summing up the foregoing principles, we deduce the following rules, to be observed as closely as possible in the planning of parlors and drawing rooms:

1. *The parlor should be conveniently near the principal entrance and not too far from the principal stairs. Its principal door should be on the public thoroughfare and at right angles to it.*

2. *It should be in shape rather oblong than square, unless it has some marked deviation in outline, such as a bay window or alcove, and it should have, if possible, more than one entrance.*

3. *The drawing room should be somewhat withdrawn from the principal entrance to the house, but should open directly upon the public thoroughfare, and also, if possible, into the morning room.*

4. *It should command the best view the situation affords, and should have at least one window towards the sunset.*

5. *It should be oblong with marked departures from a formal outline, by means of bay windows, the irregular introduction of a fireplace, or other features that will separate the guests into informal groups.*

90. The **library**, though so called, may be anything, from a general family reading and writing room to the most secluded retreat of a professed litterateur.

There may be found in almost every house, except the merest cottage, a room set apart almost exclusively to books and the uses of books, but the shape, size, and position of

this room as regards the rest of the plan cannot be determined until it is known just how many volumes are to be provided for, and exactly what use is to be made of them after they are on their shelves. No exact rule can be laid down for the proportioning of bookcases to number of volumes, as books differ so materially in both length and thickness; but an allowance of eight volumes to each square foot of front area of bookcases will generally provide ample space, unless there are an unusual number of large books. The best way is to make an accurate count of the books to be provided for, and to arrange the cases accordingly. The shelves should be movable, so that they may be raised or lowered as occasion may require, and the top of the case should not be more than 7 feet from the floor, as it is not desirable to reach higher, except where the number of books is very large and the bookcases extend to the ceiling in order to avoid the necessity of a larger room than the proportions of the plan could afford. The importance of arranging the shelves so that at all times of the day they may receive ample light must not be overlooked, as nothing is more annoying in a bookroom than to be unable to read distinctly the title of each volume on the shelves.

The position of the library depends upon whether it is to be a general family room or a literary workroom. In the former case, its best position would be upon the principal thoroughfare and in direct communication with the drawing room or morning room, as may be desired, privacy being necessary only to a small degree in a room of this kind. But where the library is above all else a workroom, it must be kept well isolated from the family living rooms, with an entrance from the principal thoroughfare, and also one from a secondary branch of the same, or even from the service thoroughfare. Separation is sometimes so urgently required that it may be necessary to place the library upon the second or third floor, or, in extreme cases, in a partially or wholly detached structure. The latter case is quite necessary where a large and valuable collection demands a fireproof apartment. In shape the library is better oblong than square, for the reason

that it so affords better separation where two or more persons are using the room at the same time, and a large bay window should be included in the plan if possible. The greatest care will scarcely prevent a large collection of books from gathering and holding dust, so that a lavatory should be located near the library. There should also be a veranda which can be approached only through the library, or, if connected with the main veranda, it should be so arranged as not to become a thoroughfare.

91. The following rules should be borne in mind regarding the planning of the library:

1. *If used only as a general family reading room, it should form a part of the principal suite and open into the drawing room, morning room, or reception room, as the circumstances may require.*

2. *If used chiefly as a literary workroom by some one member of the family, it should be upon a retired branch leading from the private family thoroughfare, near the stairway; and this branch of the thoroughfare should be private and used exclusively for the purposes of the library. It should have convenient communication with a lavatory, with a door upon the service thoroughfare, or two doors on the private family thoroughfare, at different parts of it.*

3. *Should there be a private workroom or study in connection with a larger family library, the former should communicate with the latter by a single door only, and have its own separate door either on the public or private family thoroughfare, as the owner may direct.*

92. The **billiard room** is governed in its proportions and dimensions almost entirely by the size of the billiard table it is to contain. The regulation billiard table measures 5 feet wide by 10 feet long, although a smaller size, 4½ by 9 feet, is sometimes used. The least amount of room around the table should be 5 feet, measured from the edge of the table to the wall, while 7 feet at the sides and 6 feet at the end make a much more comfortable room. It follows,

therefore, that the room will be oblong, and its least dimensions should be 15 by 20 feet. This, however, makes no provision for the accommodation of spectators, who would materially interfere with the game if they were permitted to encroach upon the 5-foot limit mentioned above; so a small, raised platform is usually provided for them either in the recess of a bay window, or in the end of the room, which in the latter case should be extended at least 3 feet to accommodate it.

A most important consideration is the lighting of the room. The conditions of the game require a uniformly distributed light, which can be depended upon at all times of day. The most satisfactory way of obtaining such is by means of a skylight, but this demands that the part of the building containing the billiard room shall be but one story high, which is not always convenient or desirable. Another arrangement is to have the windows high up in the sides of the room, or have the windows provided with shades that will effectually shield the lower part of them, the object being to cause the shadows cast by the balls to fall beneath them, and thereby not cause false impressions as to distance, etc.

As to location on plan, the billiard room should be situated upon a more or less retired branch of the main public thoroughfare. The room is essentially a noisy one, formal restraint is abandoned, and much freedom of action prevails. Smoking is also permissible, so that there are obvious reasons for the separation of the room from the principal rooms of the same suite. At the same time, being a family room, it must not be so far retired as to be wholly upon the service thoroughfare. Hence, we often find it placed at the front of the house opposite the reception room, with its door not on the entrance hall, but on a lobby off the main hall. In city houses, we often find it located in the basement; in small country houses, it is usually arranged in the attic. The owner's wishes should always be consulted before its location is indicated on the plan. It is often advantageous that the billiard room should have direct communication

with the service thoroughfare, for the sake of convenient service from the pantry, and it should also be closely connected with the lavatory. The construction of the floor must be such as to prevent vibration, and be made absolutely level.

93. The **music room** is subject to a wide variation in both form and size, according to the purpose for which it is used; and, like the library, it may be simply a family gathering room, containing a piano and a cabinet of music, where the latest waltz or the overture from some prominent opera may be listened to after dinner, when a small room opening into the parlor or sitting room is all that is required. Its shape is of little importance so long as a large opening connects it with the adjoining room and there is space enough to place the piano in front of this opening. Pianos vary in size and shape, the square grand being 7 ft. × 3 ft. 6 in., while the upright grand is about 5 ft. × 2 ft. 6 in.

In large houses a room is set aside exclusively for the entertainment of the family and friends, in which elaborate musical programs are rendered. Such a room requires careful study in its proportions as well as in its decorations, in order that none of its acoustic properties may be destroyed in trying to obtain artistic effect. The room should be decidedly oblong in shape, and the best effects are produced when the length is a little more than twice the width. The walls and openings should not be draped or hung with curtains, as such are fatal to acoustic effects. The floor should be of hard wood, and uncarpeted, save for rugs here and there which may be removed on the occasion of a concert.

It should not be located on the main public thoroughfare, though it may have an entrance on a small branch of the same, and folding doors should separate it from the drawing room or parlor when they adjoin it.

94. The **morning room** and **reception room** are very similar in their forms and functions. They are usually to

be found only in houses where the drawing room is used almost exclusively for formal evening entertainments, and either one serves as a place to receive afternoon callers.

They are very rarely both found in the same house, but when they are, the former serves more as a family room, particularly for the ladies of the household.

In this latter case, the morning room is usually located upon the private family thoroughfare near or adjoining the breakfast room or dining room, preferably the former, and in some instances it serves as a breakfast room as well. The reception room is then situated upon the main public thoroughfare between the main entrance and the entrance to the drawing room.

In size, these rooms will vary according to the house in which they are placed, but an average of about 12 feet square, or from 150 to 200 square feet of floor area, is what they are usually made. Where there is but one such room in the house, it is usually the reception room and is arranged as described above.

95. The **kitchen,** when it is conveniently placed, well arranged, and well lighted, is such an important factor in the domestic economy of the household that it deserves almost as much attention as the dining room or the library. The range must be placed where it will receive good light and have plenty of working space around it; the sink, work table, and dresser should be placed near by and convenient to each other, and all of them to one side or the other of the thoroughfare through the room, from the pantry to the next room on the opposite side of the kitchen, or in whatever direction the traffic is likely to take place.

Where it is possible to do so, the kitchen should be lighted from two sides, opposite ones being most desirable. This arrangement provides the best ventilation during warm weather, and at the same time precludes the possibility of dark corners. The storeroom should have a window of its own, but it should be so placed that the direct rays of the sun may not enter it and thereby heat it unduly in warm

weather. The location of the kitchen with reference to the dining room has already been discussed, and all that need now be said is that it should be as close as possible to the dining room, in order to reduce travel, but should never, under any circumstances, have a door opening directly into the dining room. Usually the kitchen is about the last part of the house laid down on the plan, and is assigned any place which has not already been set apart for other rooms whose aspect is of more importance. The kitchen should have a cool place, such as the north or northeast corner, with at least one of its windows so placed that it will let in the sunshine during a part of the day. The northwest corner of the house is an exceedingly bad location for the kitchen as it is likely to be unbearably hot on summer afternoons, and, if protected by verandas or porches, the sunshine, so necessary as a sanitary element, would be excluded all day.

96. The **servants' hall** should be placed next or near to the kitchen and should be an adjunct to every house where there are more than two servants. It serves as a dining room as well as a sitting room for the servants, and should have a separate entrance on the back porch, as well as a door on the back hall or servants' stairway. In arranging its windows, care should be taken to place them so they will not directly overlook any part of the premises where the family is likely to congregate, such as tennis courts, summer houses, etc.

97. The **laundry** should always be separated from the kitchen when practicable. Although the laundry work generally occurs but once a week, it should not be performed in the kitchen, as it always interferes with the smooth running of the culinary department. Sometimes the laundry may be very conveniently located in the cellar, directly under the kitchen or pantry, and if the bathroom can then be placed directly over the pantry, all the plumbing fixtures will be over one another, which is a very desirable and economical arrangement. When the laundry is on the same floor, it

should be next to the kitchen, with its tubs on a line with, and as near to, the kitchen sink as possible. The kitchen range should be on the side next the laundry and its chimney stack should carry a flue for the laundry stove, of which we will speak again later on.

98. The following rules for the kitchen and service rooms should be borne in mind:

1. *The kitchen, laundry, servants' hall, etc. must be thoroughly but conveniently separated from the family rooms and thoroughfares.*

2. *The kitchen must be well lighted with windows on opposite sides when practicable, but not overlooking the principal parts of the lawn, etc.*

3. *The kitchen ought to be compactly arranged with reference to the execution of the required work by the smallest number of servants usually engaged in the class of house under consideration.*

99. The **bedroom floor** is governed very much by the subdivision and shape of the floor plan below, hence it is frequently necessary to make various alterations in the first-story plan before we can arrive at a satisfactory disposition of our bedrooms and chambers. The fundamental purpose of the bedroom is undeniably to provide a place to sleep, hence it would appear quite unnecessary to say that in planning every such room, a well considered place for the bed should always be provided. Yet it is nevertheless true that many plans are drawn which are devoid of such a provision. In many of the published plans for country houses, the bedrooms are so arranged that the bed must stand either beside a window or so close to a door as to be visible in the hall when the door is slightly opened.

In designing a small house, it is always best to select a place in each bedroom for the location of the bed and then draw the bed in position on the plan before the windows are arranged or the closet doors located. The bed should be placed beyond the line of all possible drafts, and in such a

position, that, should the door be left half open, it will be screened from view.

A double bed measures 6 ft. 6 in. × 4 ft. 6 in., and should be placed with its head against the wall and both sides open and free. A single bed is from 2 feet 8 inches to 3 feet wide, and may, if desirable, be placed as suggested above, but it is generally arranged with its side to the wall or is pushed up into a corner. A bureau is usually about 3 ft. 2 in. × 1 ft. 6 in., and a suitable position should be provided for it when the bedroom is planned.

There is a great choice of locations for bedrooms, and careful study must be given to the plan both when locating and lighting them for different members of the family. In nearly all houses there will be at least two rooms on the second floor connecting through a dressing room, or, in some large houses, with a dressing room for each. This is the principal suite of rooms, and generally has the place of honor, at the top of the main stairs. If there is to be a nursery, it should be near these connecting rooms and also convenient to the bathroom and service thoroughfare.

The guest room or rooms should be near to, and in plain sight of, the family staircase, while the other bedrooms may be distributed as space occurs or special conditions warrant. As has been said before, the subdivisions of the floor plan below govern the location and size of the bedrooms very largely, and, as will be hereafter shown, it is absolutely necessary to bear every part of the house in mind when each individual part is being planned. A change in the outline of the first-story plan will change all the floor plans above it, and at least one elevation and section, and all this must be taken into consideration before the change is made. In locating windows in bedrooms, it is well to remember that west and northwest rooms are exceeding hot on summer afternoons, and cold and dark on winter mornings; therefore, it is desirable to keep the more important sleeping rooms on the east and southeast sides of the house, where they will receive the refreshing morning sun, and be cool and inviting in the evening.

100. The **bathroom** must be so placed that it will give the most direct lines for waste pipes, and at the same time have its supply pipes free from exposure to cold weather. It must also be convenient to the principal bedrooms, and is better near the top landing of the main stairs. Regarding the first consideration, it should be understood that the water closet must be so placed that the soil pipe runs straight down from its connection with the trap under the hopper, to the place in the cellar where it turns to run towards the sewer or cesspool. The bath tub and wash basin, whether in the same room or adjoining, can have their waste pipes carried along under the floor, and connected with the vertical soil line. On this account, it is obvious that there is much economy in having the plumbing fixtures of the first floor directly under those on the second floor, so that one soil or waste line may carry the discharge from all. The hot and cold water supply pipes must be protected, so that they will not destroy walls or ceilings in case of leakage, and in all cases should be as accessible as possible, in order to be readily repaired in case of leakage or freezing.

The bathroom should have a sunny exposure, and, above all, should be well lighted, as the healthy condition of the house depends largely upon it. The water closet should, if possible, be separated from the bathroom, so that one may be used without closing access to the other. When there is more than one water closet in the house, this is not of so much importance. The usual sizes of bathroom fixtures, as drawn in house plans, are 2 ft. 6 in. wide and 2 ft. deep for water closets, 3 ft. 3 in. wide and from 5 ft. 6 in. to 6 ft. 6 in. long for bath tubs, while the smallest convenient slab for a 14-inch wash basin is 21 in. × 24 in.

CITY HOUSES.

101. The private residence, as has been said before, is, like a man's coat, designed to fit his requirements, and not those of anyone else; the office building, theater, lecture

hall, etc., on the contrary, are designed to suit a collection of people and not the tastes of an individual.

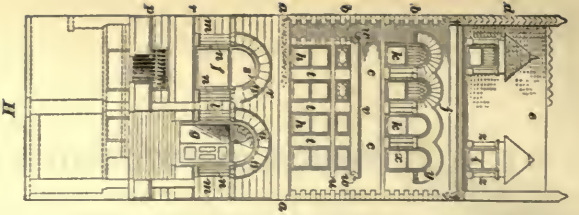
The private residence presents to the architect exactly the same kind of problem, whether the house is to be erected in the city or in the country. The former problem may be more complicated, owing to the restrictions imposed by a narrow lot walled in between two other buildings and permitting window openings and door openings to the proposed structure at the front and rear only, while the country house is usually open on four sides and is still further susceptible of extensive illumination of special rooms by the throwing out of a wing or large bay window; therefore, the rules just laid down governing the aspect of various rooms cannot be said to require strict adherence in an ordinary city dwelling, but they should be borne in mind and carried out as closely as the circumstances will permit.

The size, shape, and proportions of rooms will be governed by the same laws or circumstances, be the house city or suburban, but the position of the streets regarding the points of the compass will render it difficult, and perhaps impossible to have the light enter the principal rooms from the most desirable direction. Even this can be compensated in most cases, as the plans in Plate I will show.

102. This plate shows a set of plans for a city dwelling on a 25-foot lot, designed to suit the requirements of the following problem:

A member of an American legislature, possessing a large and valuable collection of books, desires a house planned with a spacious parlor, and a dining room on the first floor large enough to seat a dozen people; a library or study in a more or less secluded part of the house, and a nursery for his two children in the upper part of the house, particularly remote from the library, but near to or adjoining the nurse's bedroom.

Two large family bedrooms must be provided, and, on the top floor, sleeping accommodations are required for two female servants and the butler.



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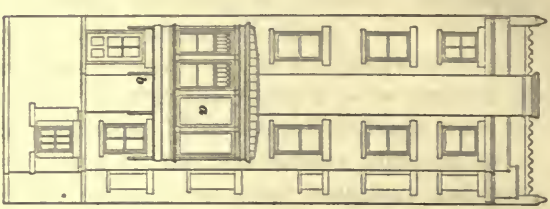

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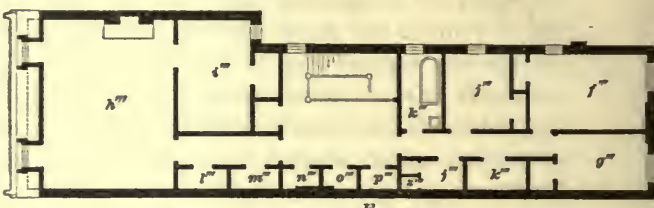

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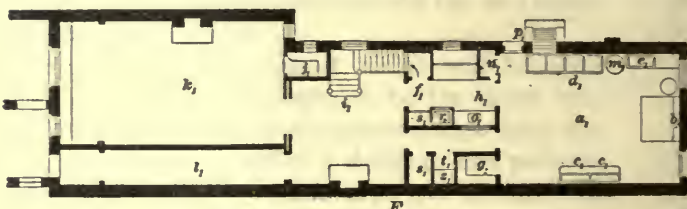

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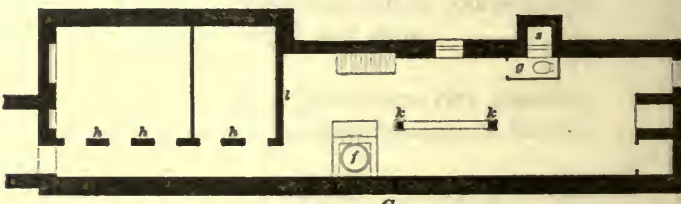

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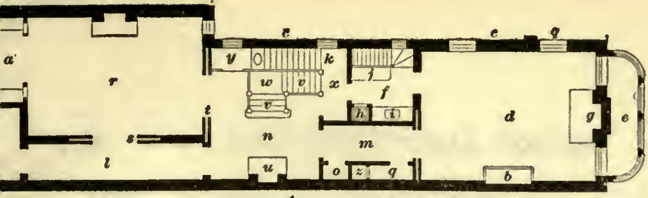

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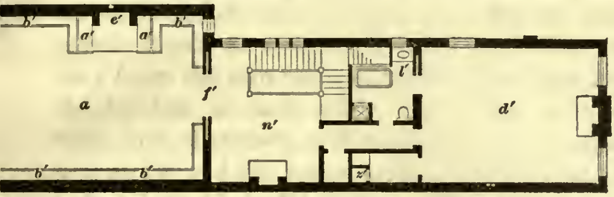

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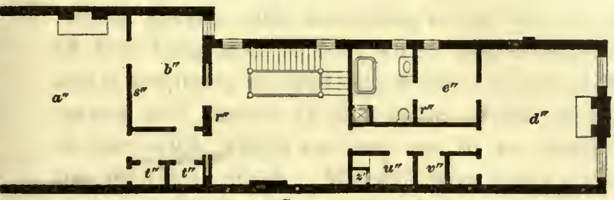

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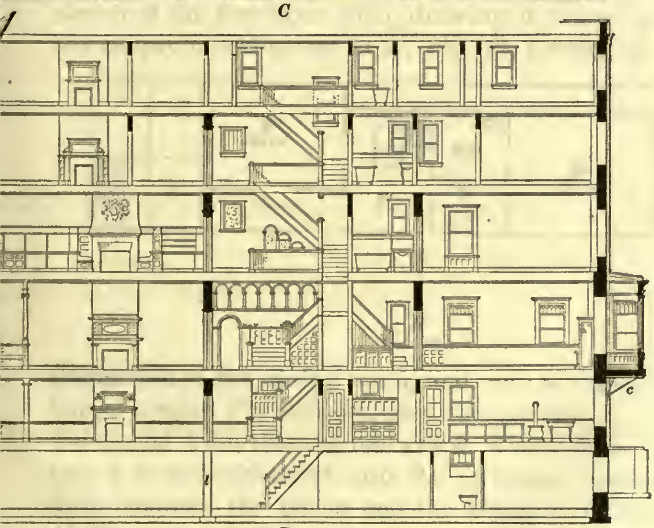


D

L

103. In possession of this information, we will proceed to solve the problem before us. We are limited by a lot which is only 25 ft. × 100 ft., and the house can be lighted only from the two ends, as other houses are built close upon the lot line at each side. The house will be four stories high, and, therefore, will require walls 16 inches thick in the first story, and the inside width of the house is consequently reduced to 22 feet 4 inches. The dining room must seat twelve people, and, according to our rule, must be at least 19 feet long and 11 feet wide; but, to allow for furniture and a fireplace, we will add 5 feet to each of these measurements, and assume 16 ft. × 24 ft. as the proper dimensions to start with, which we may see fit to change if it crowds the plan too much. We will now make a rough, freehand sketch of the first-floor plan, drawing it to no regular scale, but simply blocking out at *D*, Fig. 97, a room of about the

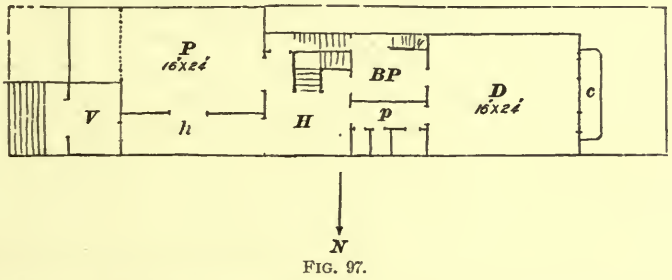


FIG. 97.

proportion of the dining room, and, on the other end of the house, a room *P* which occupies the position of the parlor. We cut off from this the hallway *h*, which would be about 5 feet 6 inches wide, and also the entrance vestibule *V*, and fit in between the parlor and the dining room the stair hall *H*, the pantry *B P*, and the private hall *p*. We calculate the minimum sizes allowable for each of these rooms in the same manner as we did for the dining room, and mark the determined size on the sketch, and with this freehand sketch as a guide, we proceed with the scale drawings shown in Plate I.

104. This illustrates the method used in the offices of architects in preparing and comparing all the preliminary

plans. *A*, *B*, and *C* show the three principal floor plans, placed immediately over the longitudinal section *D*, so that the value and position of every partition may be seen in all four drawings at once; while at *H* and *I* are the front and rear elevations, so placed that the position of every longitudinal partition can be seen in the plan above and located behind the walls. Along the edge are freehand sketches *J*, *K*, *L* of nooks and corners and odd pieces of detail, the general effect of which requires study and consideration before they are worked into the plan. Any change in design or construction can thus be transferred from the plan in which it is made to each of the other plans, as well as to the section and elevation, and, in the reverse order, any change found necessary in the elevation or section can be immediately given its proper relation in the plans.

The determination of the proportionate sizes for the different rooms is arrived at by the methods given under the rules for planning each room; and, as the owner of this house is desirous of having accommodations for the entertainment of a dozen or more guests at one time, we must plan his dining room accordingly. His parlor or drawing room must also be carefully planned and proportioned to receive and entertain his guests after dinner. The parlor is, therefore, made the same size as the dining room, with the addition of a window seat at *a*; this, with the omission of the long table, which so fills the dining room, will give plenty of moving space on the occasion of an evening reception. Our rules for planning dining rooms require *that the exposure must be easterly, or southeasterly, and never towards the west.* But here we have a lot that faces directly east and west, and unless we place our dining room in the front of the house, we must apparently take our light from the west. At *A* is a plan of the first floor, which shows how we can arrange the dining room *d*. The minimum width of the dining room is 11 feet, but this one we have made 16 feet in the clear, between the walls, allowing 5 feet for the buffet *b* and other movable furniture; and, as our lot is 25 feet wide, we can have outside the dining-room walls a

small light court *c*, which will also serve as a lighting and ventilating shaft for the central rooms. The window *q* admits light from the southwest, while the strong western sunshine, which is so objectionable at the time of the evening meal, is tempered by passing through the conservatory *e*. The buffet *b* is so placed that it will be well illuminated by both lights, and so fits another desirable condition laid down in our rules. The fireplace *g* is conveniently placed at the end of the room and serves in this position to keep frost from affecting the plants in the conservatory *e*. At *f* is a butler's pantry with its dumb waiter *h* connecting it with a kitchen pantry below, and *i* is a sink for washing the fine china, while *j* is the closet where this china is kept. At *k* are stairs to the kitchen below, by which the butler has access to the kitchen at all times. The dining room here is not situated upon the entrance thoroughfare, which is at *l*, but upon the private family thoroughfare *m*, near its junction with the public family thoroughfare *n*. A careful comparison of these details with requirements under the rules for a dining room will show that it conforms as closely as can be expected under the circumstances.

105. Our next consideration should be the parlor *r*, and after allowing 5 feet 6 inches for the clear width of the entrance hall *l*, we have for the width of the parlor 16 feet, and by making it 24 feet long, we get a room the same size as the dining room, which conforms in its location to rule 1 of our directions, but is not in accordance with rule 2 as regards its shape.

This, however, is not necessary, as the room can be considered as a drawing room and will be found to conform to rule 3. Much can be accomplished by the addition of the little window alcove at *a* and the placing of the fireplace in the center of the room opposite the door. This latter feature practically divides the room in half and would serve to separate guests into the informal groups required by rule 3. The impossibility of having a window here looking towards the sunset is too evident to require explanation, and even though

it were possible, it is more than probable that the houses on the opposite side of the street would cut off any such view. The wall spaces are well arranged for picture hanging and the sliding doors at *s* and *t* admit of a treatment with portières which will be of much value in furnishing the room.

106. The stair hall *n* is placed in the center of the house in this case, in order to utilize the best lighted portions for the more important rooms. The arrangement of the stairs is studied with a due consideration of the interior effect, and the mantel and fireplace at *u* are introduced more with this idea than for actual service and use.

The prominent structural features of the hallway are the stairs *v* and landing *w*, and we therefore make these structural necessities the very means of our interior ornamentation. The height of our ceiling in the first story is to be 12 feet, and if we then allow 1 foot for the thickness from the ceiling to the second floor, we have 13 feet of altitude to be overcome by the stairs, for which 22 risers will be required. These we dispose in three short runs, in order to reduce the exertion required by a long tedious flight, and, also, to add picturesqueness to the hall. Having arranged the first run of five risers *v*, and planned to have an open balcony at the second landing *x*, we find it advisable to make a little sketch *J* of the interior effect of this stair and balcony landing, in order to get an idea of the full force of this treatment in the hall. At *J* is shown the appearance of the stair hall as viewed from a point somewhere near the door as we enter it from the hall *l*. In this sketch, shown at *J*, we have the first run of five risers *a*, and the balcony above referred to exists behind the arches *b*, while the arched openings *c* are carried along to cover the third run of the main stairs which extends from the balcony to the second floor.

107. Having found this arrangement satisfactory, we now proceed to the second floor *B*, and in the front of the house, at *a*, we locate the library.

The library we will consider in its stricter sense, that of a

literary workroom, such as might be required by a lawyer or an author, and it is for this reason that we plan it on the second floor of the house. The walls are lined with the bookcase *b'*, and a window seat is built in at *c'* in lieu of the desirable bay window described in our rules for the library plan. The privacy demanding the placing of this room on the private family thoroughfare, is accomplished by its situation at the head of the main stairs and its entrance on the family hall *n'*. On account of the economy of locating all the plumbing fixtures over one another, the nearest point at which we can place the lavatory is at *l'*, but as the only other room on this floor is the bedroom *d'*, complete privacy can be maintained at all times. The interior walls in the front part of the house are built with brick to the top of the library ceiling, and the library floor and ceiling, and the floor of the parlor and hall *b*, are constructed with iron beams and terra-cotta blocks, to insure the safety of the books and papers in event of the house taking fire, while metallic sheathed doors at *f'* shut off the hall and stairs.

The interior finish of the library is made effective by means of the artistic arrangement and treatment of the bookcases *b'*, and after making a preliminary sketch at *K*, we decide to include in the arrangement a chimney seat *a'* placed on each side of the fireplace *e'*. The details of this seat and the final treatment of the mantel and bookcases are all left for future consideration, but the general paneling of the woodwork is expressed in the sketch *K*. This sketch is assumed to have been made before the plans are fully developed, so that the subsequent insertion of a window over the bookcase has not been embodied in the sketch. A similar sketch *L* shows the effect of the dining-room mantel and conservatory doors, and also gives us an opportunity to study the treatment of the walls and windows in the room before we finally locate them on the plan.

108. On the bedroom floors, we are governed very much by the location of the partitions on the floor below; so that we first draw the partitions *r''* over the divisions at

each end of the stair hall, and thus have a bedroom a'' in the front of the house which would be about the same dimensions as the library below, but this being unnecessarily large, we subdivide it by the partition s'' and provide a dressing room at b'' and two liberal closets at t''.

The plumbing fixtures below necessitate the location of the bathroom on this floor directly over the bathroom on the floor below, while the rear room at d'' will be a desirable location for the nursery, and e'' a room for the nurse. Along the north wall at u'' and v'' can be arranged closets for linen, brooms, dusters, and other articles necessary for household use.

On the top floor E will be located two servants' rooms f''' and g''' over the nursery d'', and also one large extra family bedroom h''' over the chamber a'', while over the dressing room b'' can be located a small bedroom or a storeroom i'''. Abundance of closet room should be supplied on the top floor, as at j''', k''', l''', m''', n''', o''', p''', etc., for the storage of trunks, boxes, and household ornaments during the summer, or for awnings, furniture covers, screen, blinds, etc. during the winter.

109. From the top floor we go to the basement plan shown at F, where we provide a large kitchen a_1 under the dining room, and place the range at b_1, sink at e_1, dresser at c_1, and a large storeroom, with shelves for packages, groceries, etc., at g_1. A pantry h_1 contains all the dishes necessary for the servants' use, and a sink o_1 provides a place to wash them without interfering with the kitchen sink at e_1. Along the wall at d_1 are arranged four washtubs, with the laundry stove at m_1, and a closet for the laundry materials at n_1. The door at p_1 gives the laundress opportunity to carry the clothes into the drying yard without interference with the cooking arrangements at the range b_1.

The pantry h_1 contains the dumb waiter r_1, which communicates not only with the dining-room pantry, but also opens on each floor of the house, and can be used to take meals up to any of the bedrooms in case of sickness, or to

carry coal, wood, or other fuel for the open fires in any of the rooms upstairs. Stairs at f_1 communicate with the cellar, and at i_1 the main stairs go up to the landing shown in the first-story plan A at k. In the front of plan F we have a large room k_1, which may be used as a servants' hall, and at l_1 is a passage communicating with the street, where tradesmen can enter and deliver their goods.

110. In many instances where a servants' hall is considered unnecessary, the room k_1 is fitted up for a billiard room, although it is not as desirable a place as would be any room on the top floor, where a skylight could be provided. At j_1 is a closet for the reception of table linen, etc. used in the servants' hall, while at s_1 are closets for the storage of sundry necessities of household use.

On each of the floor plans, except the cellar G, there is shown at z a *chute*, or shaft, which is open from the top floor to the basement, and is used for the transfer of clothes from the various bedrooms to the laundry. As the chambermaid arranges the rooms, or changes the bedclothes in the morning, she simply folds up the soiled linen and drops it down to the basement closet, where it is afterwards collected and washed by the laundress. This device avoids the necessity of carrying the soiled linen down stairs, or of using the dumb waiter for it, which would require the attention of another servant below to remove it as it was sent down.

The cellar plan G contains the furnace f and a water closet for the servants at g with its ventilating shaft, shown at s. In the front are bins for the storage of wood and coal; the piers h and arches between them carry the wall between the servants' hall and passageway in the basement, and the wall between the parlor and entrance hall in the first story; the piers k and girder supported by them carry the partition, against which the dumb waiter runs from the basement to the third floor.

111. We have thus analyzed each floor plan separately, and have considered the necessities of each story as we came

to it, but that is not the way we should draw the plan itself. Our preliminary freehand-sketch plan in Fig. 97 has given us certain desirable arrangements and combinations to work from, but we cannot tell to what extent we can make use of them until we develop the scale plans, as shown in Plate I; and, as said before, we can only arrive at the most satisfactory results by giving the closest study to the effect of each feature as it is introduced into the plan. A concentrated study is best secured when all the floor plans, sections, and elevations are drawn on one sheet.

Plate I is a reduced copy of a regular office set of preliminary studies, drawn to a scale of $\frac{1}{8}$ in. = 1 ft., and the first, second, and third story plans *A*, *B*, and *C* are arranged in the manner shown, so that one can more quickly observe the relative position of the parts of each plan. The longitudinal section *D* is developed at the same time as these plans and for the same reason. In this way, when the stair hall *n* in plan *A* was being laid out, we could immediately locate the second-story hall in plan *B* and the third-story hall in plan *C*, while the position of the stair landing and the arrangement of the stairs are immediately decided by drawing them on the longitudinal section *D*.

The same may be said of each of the other details of construction, in each of the other stories. The dimensions of the parlor *r* in plan *A* had to be considered not only in relation to the desirable proportions of that room by itself, but also in connection with the library *a* in plan *B*, as the partitions separating these two rooms from the stair hall had to be maintained directly over each other; and so on throughout the building, each room and minor detail could not be considered by itself alone, but rather in connection with some other detail either dependent upon it, or upon which it was itself dependent.

112. Up to this time, no windows have been located in the front wall, and the front elevation has not been carried on as rapidly as the plans. The reason for this was that no longitudinal partitions of importance exist on any floor, that

will materially influence the treatment of the window openings in the facade. So that now, when we come to block out the front elevation, we have simply a plain wall 25 feet wide and from 60 to 70 feet high, whose character and expression are dependent upon the materials used and upon the *fenestration*, or window arrangement.

113. As to the architectural style to be exhibited in the elevation and details of this house, we must be influenced by the appropriateness of its application to the tastes and customs of its owner. Italian Renaissance of the Roman school is out of the question, as the house is too small to successfully carry such severe and monumental treatment. The style of Francis I would be appropriate, but its elaborate detail makes it expensive and beyond what we consider would be the most economical cost of our design; besides, this style is essentially French in its character, and the owner of the house is supposed to be more strongly identified with American sentiments than with those of any other particular country. Gothic architecture is not adaptable to *urban*, or city, buildings, except where such are located within extensive grounds, or on a water front, so that a sufficiently distant view may be had to observe the variety of detail and outline at one glance; Elizabethan is essentially English and not acceptable for the same reason that Francis I was rejected, and American colonial is best adapted to *suburban*, or country, work.

If we now consider the Romanesque, we will find in it none of the objections of the above mentioned styles, while it is particularly adapted to our desires.

Romanesque architecture is not associated with any particular country. It was practised in all civilized countries of the old world, but was slightly modified according to locality and circumstances. It is not necessarily expensive, as it can be treated with severity or elaboration, as desired, and can be executed in stone, brick, or timber. It is expressive, and while lacking the cold severity of the Grecian classic, it also avoids the plaster sham of the later Renaissance. Besides all this, it is appropriate to American

structures, for it was developed in the European countries under conditions somewhat similar to those existing in America today.

114. We will, therefore, design the facade in American Romanesque. At *H*, Plate I, is the elevation as we finally complete it; the front wall to the top of the second-story beams is built with rock-faced ashlar, while the parlor window *f* and the main entrance *g* are each spanned by a bold semicircular arch. The arches have equal radii, and are separated by the pier *l*, and abutted by the piers *m*, of a width equal to *l*. These three piers *l* and *m* have each on the side next the opening three semidetached columns *n*, upon the capitals of which the voussoirs *o* of the arches rest, while the bases of the columns rest upon the sill-course.

Around the *extrados*, or outside line *r*, of these arches is formed a hood mold, while the *intrados*, or inside line *s*, is molded. The form of these moldings will be similar to those shown at *A* and *h* in Fig. 2 of plate entitled, Door and Window Treatment, *Advanced Architectural Drawing*. The style of the capitals of the columns is also shown on this drawing plate. At *a*, on the elevation in Plate I, is a sill-course finishing the ashlar front, upon which the brick wall *c* is started. This sill-course is molded in the form of a projecting quarter round with a fillet on each side, and is carved with an ornament similar to that shown at *B*, in the drawing plate above referred to. The windows *h* open into the library, and, in order to light the room thoroughly, they are extended up nearly to the ceiling; on account of this height the transom bar *u* is introduced, and the transom sash is glazed with leaded and stained glass so as to secure a more attractive interior effect. The piers *t* separating the four windows are of brick, but the transom bar is of stone similar to that of the first story, as are also the quoins at *b* and the lintel and the dripstone *v*.

This dripstone *v* is molded on top similar to the scroll moldings shown at *d* in Fig. 62, *Architectural Design*, § 21,

but the under side of it is not so deeply cut and the ends are finished with a carved leaf, as at *w*, Plate I.

The windows *k* open into the principal bedroom of the house, shown at *a''* in plan *C*. These windows are separated by stone mullions *x*, upon the faces of each of which are carved two semidetached columns similar to those at *n* in the first story, but not so large or so elaborate. The arches *y* are of stone voussoirs similar to those at *o*, but molded on the extrados only.

At *j* is a stone cornice projecting slightly from the face of the building and forming at the same time a sill-course for the two dormer-windows *i*. These dormers are flanked on each side by a stone pilaster *z*. The dormer roofs are covered with tile, as is, also, the Mansard roof *e*.

The steps leading up to the entrance are flanked by a stone parapet in place of a balustrade, and this is carried along the front of the areaway, as shown at *p*. The dotted lines in the elevation *H* show the depth to which this wall is carried in order to secure a firm foundation.

115. The treatment of the rear elevation *I* consists of simply showing the openings on the outside, with a stone lintel above each of them and the wall carried up in plain brick. The conservatory *a* is projected from this rear wall and supported on brackets *b*, as shown also in the section *D* at *c*. The material of which the conservatory is built is iron—a skeleton frame covered with copper and filled with porous terra-cotta brick, to give warmth. The windows of the conservatory are as large as circumstances will permit, and the roof is of heavy ribbed or wired glass to admit all the light possible to the growing plants.

This completes the study of our preliminary sketch, and when it is approved by the owner, we start to make our working drawing on a scale of one-quarter of an inch to the foot.

COUNTRY HOUSES.

116. The planning of a country residence is, as a usual thing, much less restricted than in the case of a city house, but the questions of aspect, communication between, and

location of rooms, at times so complicate the problem as to make the desired arrangement very difficult. Many of these country residences are erected by people who expect to occupy them only in the summer, and who have a town house wherein they spend the winter season. Life in these summer residences, or villas, as they are sometimes called, assumes a less formal character than in the urban houses, and the planning and furnishing should exhibit an expression of hospitality and welcome, rather than the stiff regulation required by the formalities of society in its winter abode.

117. We will now consider the problem of building such a residence for a family consisting of the owner, his wife, grown daughter, and two small children. The desires of the owner are for a large and hospitable entrance hall, with the staircase rising from it; a drawing room for the entertainment of his guests in the evening and the reception of callers during the day; a library that will be a family reading and letter-writing room, or a room for indoor amusement on rainy days, and at the same time serve the owner as a quiet retreat where he can, when he desires, attend to his commercial correspondence or receive a business caller. A billiard room is desired, large enough to contain a full-sized table and have a platform at the end wherefrom guests may watch the game. The dining room must be sufficient to seat eight guests besides the adult members of his family, and a wide veranda must extend the full length of one side of the house, preferably the east or southeast. The second floor must contain a large sleeping apartment for the owner and his wife, a bedroom for his daughter, and a nursery communicating with both the owner's room and the nurse's room. There must also be two large guest chambers, somewhat separated from the family apartments, but convenient to the main stairs; and in a wing apart from the main house must be provided, over the kitchen, etc., separate rooms for four servants and a housekeeper—the servants being a cook, laundress, waitress or maid, and a butler—two bathrooms being arranged on

the second floor, one for the family and one for the servants.

As the house is to be occupied late into the fall season and possibly through the winter holidays, ample provision must be made for heating it, and open fireplaces are to be built in all the principal rooms of the first story, in addition to the furnace in the cellar.

118. Before laying out the plan, we must first consider the principal rooms and determine upon their sizes. The dining room is required to seat eight guests besides the owner's family, or eleven in all, and according to our rule the length of the dining table would be 5×2 ft. 4 in., or 11 feet 8 inches. Adding to this length 2 feet for the necessary armchairs at the head and foot of the table, and a passageway of 3 feet 6 inches for service at each end, we have a total length required for the dining room of 22 feet. But there is to be a fireplace in the room, and if we place this at the end, which is the best place for it, we must allow 2 feet more to accommodate the hearth.

A dining table nearly 12 feet long should be about 5 or 6 feet wide, and with proper allowance for chairs and a passageway behind them, we find the dimensions of our dining room will be about 16 ft. $\times$ 24 ft. The next room whose dimensions are practically governed by absolute measurements, is the billiard room; it must be at least 15 ft. $\times$ 20 ft. The parlor, or drawing room, should be about the same size, or a trifle larger than the dining room, and its shape should be rather oblong than square, in a house of this character. The dining room, being 16 ft. $\times$ 24 ft., contains a floor area of 384 square feet, so that we can consider an area of about 400 square feet as adequate for the parlor. The library is usually governed by the number of volumes it is to contain; but as in this case it is to be used as a family room, it should be about the same size or a trifle less in area than the dining room. It should be borne in mind, in planning the library, that the bookcases will take off from 16 inches to 18 inches all around the room, and that a library table about 4 ft. $\times$ 6 ft.

will occupy the center. Therefore, allowing about 5 feet 6 inches clear space between the library table and bookcases for chairs, etc., and assuming the bookcases to project 18 inches from the wall, we have for the library a room 18 ft. × 20 ft., which is ample for our purpose. When we consider the hall, which by the terms of the problem is to be large and hospitable, we will assume its dimensions to be not less than 16 feet wide, and that it extends the full depth of the house, with an entrance at each end. We cannot well determine its length until we arrange the rooms in the preliminary sketches, and decide upon the depth of the house.

119. The kitchen does not necessarily increase in size proportionately with the other rooms of the house; where there is but one cook employed, as is usually the case in private residences, she can prepare a meal for twenty persons in a kitchen of the same size as would be required to serve but six, and beyond a certain limit every increase in size of kitchen means more steps to be taken from table to dresser and dresser to range. Therefore, if we place a table 3 ft. × 4 ft. in the center of the kitchen, and allow 4 feet clear working space all around it, we have a space 11 ft. × 12 ft.; this space, which is found by experience to be a desirable one, should be clear of the dresser, the range, and the thoroughfare from the pantry to the room beyond.

The servants' hall is proportioned according to the number of servants, in the same manner as the dining room. The laundry should be preferably a long narrow room with its windows on one of the long sides directly opposite the stove. The tubs should then be at one end of the room and have windows over them. This keeps the washing at the tub end of the room, and the ironing can then be done facing the long window side, so that by simply turning around, the laundress may change her irons at the stove and continue her work with the fewest possible steps.

120. Having computed the approximate size and proportion of each room, we now prepare a preliminary free-hand sketch of the first-floor plan, grouping the rooms and

thoroughfares in such a manner as will bring each one in such a position that it will bear a convenient and desirable relation to the whole. This may require a number of sketches, each one of which is evolved on a different idea, and one similar to that shown in Fig. 98 may be arrived at

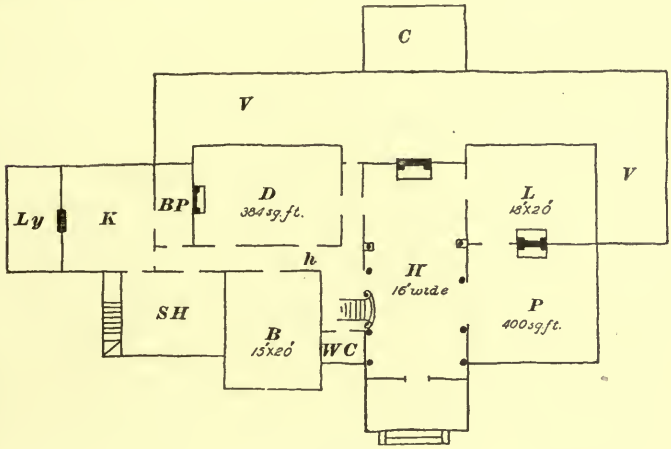
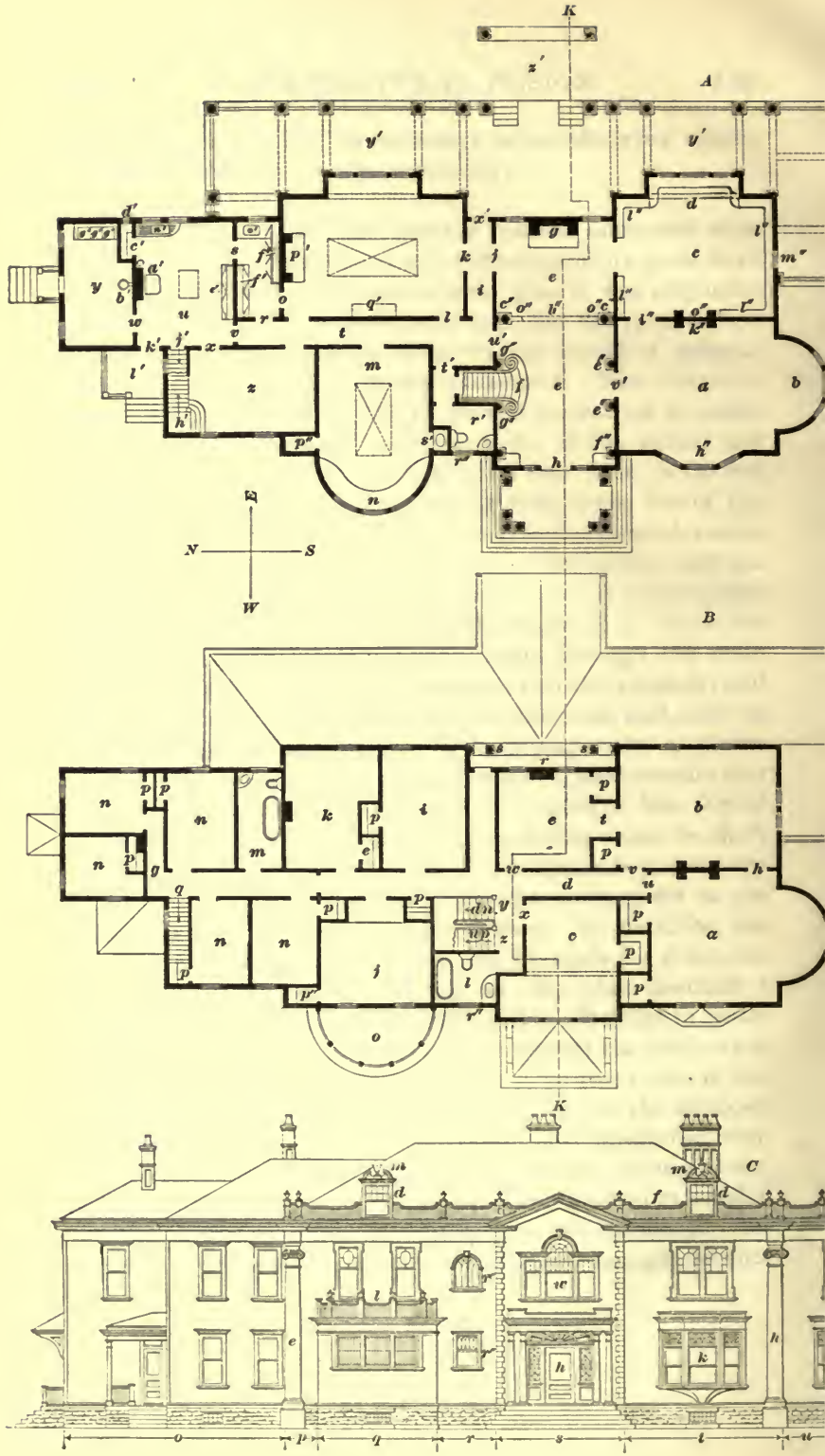


FIG. 98.

only after hours of deliberation. This sketch has no scale and is simply a block arrangement to get an idea of the proper arrangement of the rooms we require. At *P* is the parlor, or drawing room, next to the library *L*, both of which open into the main hall *H*. The dining room *D* and billiard room *B* are apart from the main thoroughfare *H* and open upon the hallway *h*; then the servants' offices, such as the butler's pantry, kitchen, laundry, and servants' hall, are grouped in the extension and shown at *B P*, *K*, *L y*, etc. The veranda *V* and porte cochère *C* are located as shown. With this sketch as a guide and the area or dimension of each of the principal rooms marked on its plan, we draw the scale sketches, wherein all the parts will appear in their true proportion and relation. As we proceed, many alterations and changes will be necessary, but we must carefully study the plans and keep before us a mental picture of each detail as it will appear both in the interior and exterior elevations.

Repeated changes will be necessary before the work can be considered harmonious and satisfactory.

121. Plate II shows the sheet of plans as perfected, after all the necessary redrawings and retracings of its parts have been accomplished. The parlor *a* on plan *A* was originally drawn 19 ft. × 21 ft., or 399 square feet, but the room lacked character and the southern elevation was devoid of individuality, so the circular bay was added at *b*. The library *c*, originally planned 15 ft. × 20 ft., proved too narrow to admit all the furniture around the center table, so the square bay was thrown out at *d*. The hall *e*, 16 feet wide, is carried through the house, but is projected beyond the line of the parlor on the west end to give variety to the west elevation and also to emphasize the entrance. The stairs *f* and the fireplace *g* in the hall are so arranged as to give picturesqueness to the interior, as one enters the doorway *h*; while the hallway *i* is provided to prevent drafts through the main hall, when the door is opened to go out on the veranda; and from this hall is a large entrance *j* to the main hall, and on the opposite side an entrance to the dining room, as shown at *k*. It would be through these doors that guests would enter the dining room on the occasion of a more or less formal dinner, while the family would, when dining alone, be more likely to enter through the door *l*. A square bay is thrown out from the front of the dining room to correspond in the elevation with the bay *d* in the library. In detailing the interior of the library, provision will be made for a window seat. The billiard room *m* has in this plan assumed a rounded form on the west end; this is done in order to better diffuse the light over the table and prevent the shadows of the balls from falling in one direction. In this curve is also provided the platform *n* for spectators, and as the windows are high in the wall, the light is in no way interfered with. The butler's pantry is arranged next to the dining room, with its entrances to the dining room and kitchen at *o* and *s*, while at *r* is a door communicating with the hallway *t*. The kitchen *u* communicates with the hallway *t* through the door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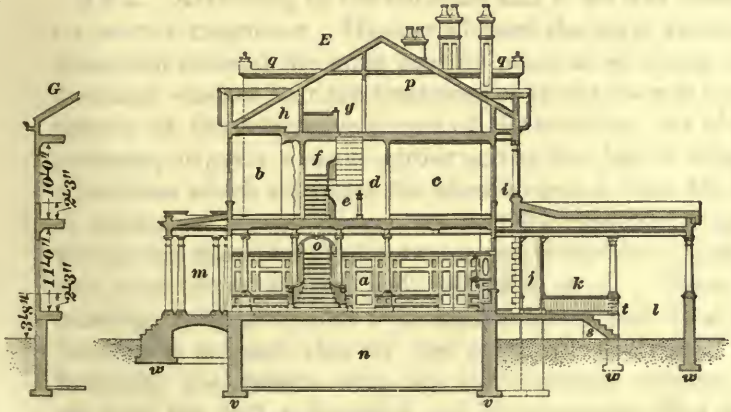
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c
d
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v, and with the laundry *y* and servants' hall *z* through the doors *w* and *x*, so that part of the kitchen between the doors *v* and *w* is more or less of a thoroughfare and should contain none of the kitchen fixtures or furnishings. The range is placed at *a'* and the laundry stove is on the opposite side of the chimney at *b'*. The kitchen sink is placed in the angle at *n'*, while to the left of it is the storeroom *c'* with a ventilating window opening out at *d'*. The dresser is at *e'*, with two smaller ones in the butler's pantry at *f'*, thus giving plenty of working room around the kitchen table without interfering with the thoroughfare *v w*. The laundry is 10 feet wide and 17 feet long and has its tubs *g'* along the end, and is well lighted by windows overhead. At *h'* are the back stairs to the second floor opening from the servants' hall *z*, while at *j'* is a door opening from the kitchen to a flight of stairs leading to the cellar.

122. Returning to the entrance hall *e*, we will consider its interior treatment. Having adopted the style known as American colonial, we must bear in mind as we locate each door and window that the treatment of its details will form a feature in the decorative theme of the interior. At *b''* it is necessary to carry a heavy girder across the hall to support a partition which separates the nurse's room *e* from the hall *d*, shown on second-story plan *B*. We therefore support this girder upon two Ionic columns and pedestals *o''*, plan *A*, and back them up by wall pilasters at *c''*. Then, by locating the parlor door *v'* in the center of that room and flanking it on each side by the attached columns *e''* and *balancing* the design with the three-quarter column *f''*, we give the hall a dignified and monumental effect without detracting from its homelike and hospitable appearance. The symmetry of the design is effected by dividing the opposite side of the hall with similar half columns and pilasters, and establishing the stairway *f* between the columns *g''* opposite the parlor door *v'*. The rail of the stairs curves around in front of the columns *g''* and hides the lower part of them from view, hence the necessity of

using pedestals, as explained in Art. **90,** *Architectural Design*, § 21.

The fireplace *g* gives the apartment a homelike appearance as one enters the door *h*, and its treatment can be made to assist greatly in the effect of the interior decoration.

The parlor *a* and library *c* are connected only by the single door *i''*, and the chimney at *k''* is so placed that it can carry the flue from the fireplace in each room. In the library the bookcases *l''* occupy all the available wall space. The small window at *m''* is placed so that its sill is above the top of the bookcases. The relative height of this window above the others on the same floor is shown at *m''* on elevation *F*.

123. The rooms in the second story *B* are arranged to bring as many of the partitions as possible over those in the first story, and we have the long center partition *g h* directly over a similar partition in the floor below. This arrangement, with a few subdivisions, gives us the required number of rooms set forth in our problem, and locates the owner's room at *a*, communicating through a door with the nursery *b*, which in turn connects by a passage *t* with *e*, which is the nurse's room. Each of these rooms communicates independently with the hall *d* through the doors *u*, *v*, and *w*. At *c* is the room for the owner's daughter, with its door *x* opening at the top of the main stairs *y*, and at *i* and *j* are two guest chambers opening on to the main hall *d*. The bathroom is at *l*, directly over the water closet *r'* on the floor below, and this arrangement brings the windows of these toilet rooms on each floor in the recess of the elevation shown on *A*, *B*, and *C* at *r''*, making them, consequently, less conspicuous than they would be in a more prominent part of the facade. Room *k* is set aside as the housekeeper's room, and is so located that she can be in easy communication with her mistress's room *a*, or with the living rooms on the floor below, while the proximity of her room to the servants' rooms *n* renders her management of household affairs more simple and convenient. The servants' bathroom is located at *m*,

directly over the butler's pantry, and at *q* is the back stairway leading to the servants' hall below.

Closets are provided for each room and the hall, as shown at *p*. At *o* and *r* are two balconies introduced to improve the character of the elevations.

124. In designing the elevations, it is well to develop *C* and *F* simultaneously, as they will be seen in conjunction; and before *F* is finished, commence on the elevation *D*, as *F* and *D* will be seen in conjunction from another point of view.

In laying out the plans *A* and *B*, we have predetermined certain divisions of the elevations—these are the projections of the main hall *e*, in plan *A*, and room *c*, in plan *B*—to form a distinctive central feature *s* of the elevation *C*, and to emphasize *h*, the entrance to the house. The recess at *r* has already been mentioned, and the reason of its existence explained.

The projection of the billiard room *m* in the form of a semicircular bay, was necessary to assure proper lighting of the table and space for the players and spectators, but there being no necessity for this appendage in the second story *B*, we finish it as an open deck or balcony *o*. The bay window is finished with a balcony rail *l*, and its general appearance in the elevation *C* is shown at *q*.

It now becomes necessary to balance this feature of the elevation with an equally important one on the opposite side of the pavilion *s*, and we construct a small projecting bay window *k*, as shown at *h''* in plan *A*. The corners of the house are finished with the two-story pilasters *e* and *h*, and the cornice resting upon them finishes the edge of the roof, while the parapet *f* gives an effective finish to the elevation.

In the nooks formed by the recession of the front wall, closets are arranged as at *p''*. Above the main divisions *q* and *t* of the elevation *C* are located two dormer-windows *d*, to light the attic. The broken pediments *m* on these dormer-windows are somewhat different from any we have hitherto illustrated, but they are prominent features in the later

examples of colonial work. Circular or rounded pediments were common in the Italian and French Renaissance, as may be seen in the Farnese Palace, Château de Blois, and Louvre Palace, Figs. 94, 104, and 127, *History of Architecture*. Over the central window of the second story of the central pavilion of the Tuileries Palace, is a window with a curved pediment, which is broken on top to receive the carved coat of arms of the Medici family. The precedent thus established was the parent of many exaggerated forms. In the florid Renaissance, broken pediments were used in every available position. In colonial work, broken pediments were used over both exterior and interior door and window openings, and as a termination of dormers; in these positions they were used in many varieties of form, having both triangular and segmental outlines.

125. The wing *o*, shown in elevation *C*, Plate II, containing the offices—as the kitchen, laundry, etc. are sometimes called—and also the servants' rooms, in the second story, is treated very plainly, with no ornamentation or other means of rendering it conspicuous, as it is desired to have it express its purpose and position. At *u*, in elevation *F*, we have the projection of the semicircular bay of the parlor, and though this is essentially a detail of the south elevation, the arrangement of its window openings must be considered with the treatment of the west elevation, as they will frequently be seen together.

126. The eastern elevation *D* must rely for its effect almost entirely upon the treatment of the veranda and the arrangement of the windows. Considered in connection with the southern elevation *F*, we terminate the end of this veranda with a wide, low gable, or pediment *a*, and carry the moldings of the cornice *c* around the side to the pediment over the porte cochère *d*. The simplicity of the second story requires the introduction of the *loggia*, or balcony *e* (in the eastern elevation *D*), which shows also on the second-story plan *B* at *r*. Over this loggia the main cornice *f* is

carried to form a pediment, which is supported by the two columns *g* and the quoins *h*, while the columns are also shown in plan *B* at *s*.

The dormers *k*, on elevation *D*, are similar to those on the western elevation *C*, and are located symmetrically in the center of the division of the facade on each side of the loggia *e*.

127. The transverse section *E* shows the elevation of the east side of the main hall at *a*, while the main stairs, shown at *f* in plan *A*, are here seen in elevation with the landing at *o*. These stairs land at *e* on the second floor, while at *f* are seen the stairs from the second story to the attic, landing at *g*. It is also seen on this section that the attic is not finished or even subdivided into rooms, but is left open for storage. The height of the ceiling *p* is set at 8 feet, and this determines the dimensions of our dormer-window *q*. At *b* on the section is shown the room marked *c* on the second-story plan *B*; the break in the ceiling at *h* is necessitated by the introduction of the *Palladian window* seen at *w* in the west elevation *C*. On the section *E* is the nurse's room *c*, and at *i* is shown the section through the loggia, marked *e* on elevation *D*. At *l* is shown the porte cochère, and at *t* is a step so placed that a person can enter the house from a carriage without stepping upon the ground, while the steps *s* are arranged for foot travelers. At *v* are the foundations of the main house, which are carried down below the bottom of the cellar *n*, and, as shown in the elevations, are constructed of stone.

The foundations of the porch and the veranda are shown at *w*; they are carried down about 4 feet below the ground line, so that the footings will not be affected by frost. As stated, the section shown at *E* is taken through the front entrance gable and the loggia gable; but, in order to show the details of the cornice, a section of the front wall is shown at *G*, giving the story heights and other details. The section *E* is taken on the line *KK*, as shown in plans *A* and *B*.

OFFICE BUILDINGS.

128. The rapid increase of commerce and trade during the nineteenth century, due to improved methods of transportation and communication, and the concentration of business offices, have been the cause of a new architectural creation—the modern office building. In large cities, such as New York and Chicago, where land is exceedingly high priced, it has been necessary to erect office buildings whose height is greater than anything ever before erected for a similar purpose. In Chicago, the Masonic Temple is twenty stories in height and stands 302 feet above the curb line; in New York, the World Building is over 309 feet; the Manhattan Building is 326 feet; and the new Park Row Building over 400 feet in height.

As the methods of construction in these gigantic buildings are fully explained in *Architectural Engineering*, we will confine ourselves here to the discussion of the design from a utilitarian standpoint.

129. The elements to be combined in the successful office building are: (1) Ease of access; (2) good light; (3) good service; (4) pleasing location and surroundings; (5) the maximum of rentable area consistent with true economy; (6) ease of rearrangement of offices to suit tenants; (7) minimum of cost consistent with true economy. The first four of these elements are of particular interest to the tenant, while the last three of them concern both the landlord and the tenant. While at first sight it might seem as though the two interests were antagonistic, second thought will readily show that the landlord who sacrifices his tenants' interests, to a certain extent injures also his own—by reducing the value of the space he has to rent. On the other hand, the landlord's interests must not be sacrificed to those of his tenant, or he may be unable to secure a proper return for his investment.

130. Ease of access can be readily secured whether the building be low or high, the difference being simply in

the elevator system; in fact, the solution of the access problem depends upon the elevator system almost entirely. The elevators should be so placed as to be reached directly from the street and only a few steps above or below the sidewalk. All the elevators should be grouped together, unless the building is very long, and so located as to front on two streets. In any case, the elevators should be so placed as to be readily seen by a person standing in the middle of the space devoted to them, so that when he wants a car, he can take the first. The character of the business in the building will determine the number of elevators, their speed, and the interval between trips. For ordinary office buildings a speed of 450 feet per minute and an interval of not more than 40 seconds between trips is considered good service. The number of elevators required will be governed by the number of offices on each story and the number of stories in the building.

An elevator car 5 ft. × 5 ft. is a convenient size, and at a speed of 450 feet per minute will serve 75 offices, if they are placed on more than two, and less than six, stories; where there is a larger number of offices, more cars will be required.

A building 25 ft. × 100 ft. which is more than four, and less than fifteen, stories high will require two cars; and in a 50′ × 100′ building there should be two cars up to eight stories, three cars for thirteen stories, and four cars for twenty stories. In a 100′ × 100′ building, four elevators will be required for ten stories, five for fourteen stories, and six for over that number.

Stairs in such buildings as these are of minor importance, as they are used only in the rarest emergencies.

There are, however, exceptions to these rules in the proportioning of elevators to the number of offices and stories —exceptions caused by the local characteristics of the towns wherein the buildings are erected, or by the peculiar conditions of the class of business prevailing in the immediate neighborhood of the structure. In large manufacturing cities it is almost universally the custom for the factory hands to stop work from noon until one o'clock in the

afternoon, and to finish the day's labors at six in the evening; and the foremen, overseers, clerks, and even the proprietors of these manufacturing establishments usually observe the same regular hours. This system causes the meals to be similarly regulated throughout the city, even in the hotels, as traveling men soon learn that parties cannot be found at their places of business between the hours of twelve and one, nor after six o'clock, and utilize these hours to eat their own meals. Therefore, in a large and multi-storied office building in such a locality, the elevator service should be increased by at least 25 per cent., either by increasing the area of each car, or by the addition of an extra car to accommodate the rush which is sure to occur at the hours of leaving and returning to work. Another exception where an increase of access facilities is not only desirable, but absolutely necessary, is in a large financial center, where a building may contain many brokers' and bankers' offices, which require to have prompt and rapid communication with neighboring banks and offices.

131. Good light is of the utmost importance in every office building, and the offices should be so arranged that each one shall, at some part of the day, receive a portion of direct sunlight. Where the building is large and requires an interior court, the axis of this court should, when possible, be at an angle of $22\frac{1}{2}°$ east of north in localities near New York City, but varying according to latitude, in other sections. When this light court is open to the south, and of a long rectangular form, which is preferable to a square one, the sunlight will, during a part of the year at least, extend to the bottom of the court, which is invaluable for sanitation and illumination.

The light must be admitted to the offices through windows, and these must be made ample. A window 4 feet wide and 7 feet high, with its top not more than 1 foot below the ceiling, will light about 150 square feet of office space. Arched openings are to be avoided when possible, as they cut off some of the light.

132. **Good Service.**—Apart from the discipline and intelligence of the employes—characteristics which do not come into the architect's province—good service requires satisfactory toilet arrangements, heating, lighting, and ventilating considerations. Each floor of the building should have a toilet room containing one water closet for every five offices, and one wash basin and one urinal for every two closets. Besides these fixtures there should be a slop sink, placed in a compartment similar to the water closets, or a small cesspool, placed in the floor of each of the toilet rooms, for the use of the "scrubs." Where there is a toilet room for women, there should be double the number of water closets in proportion to the offices, and, if possible, a space should be provided for a sofa, and a connection left out for a small gas stove. This room should connect through a small lobby with the janitor's apartments. The toilet fixtures require for their accommodation the following dimensions on plan: For each water closet 2 ft. 6 in. × 3 ft. 10 in.; each urinal 2 ft. × 3 ft.; and each wash basin 2 ft. 6 in. × 3 ft. 6 in. This space of 3 feet 6 inches includes the minimum amount of room required by a person standing in front of the fixture.

133. Heating and ventilation should be considered together, as one depends so much upon the other, and a *direct-indirect* system is the most satisfactory for this class of work. A steam radiator of proper size standing under the window, and over a cold-air inlet near the floor, will not only warm the room sufficiently in the coldest of weather, but when the transom over the door is open and the cold-air damper at the floor is so turned as to permit the outside air to circulate between the pipes of the radiator, the circulation and ventilation of the air of the office will be nearly perfect.

The modern office building should be lighted by electricity. Where there is no public supply, provision must be made for a private plant in the cellar of the building. Each office should have a central chandelier with from two to four lights, all of which may be lighted or extinguished from a

switch near the door; and there should also be a connection for a desk lamp, flush with the wall near each corner of the room.

134. Rentable Area.—The maximum rentable area consistent with economy must be considered in two parts, first as to the plan, and second as to the way the plan shall be carried into execution. First, there must be on each of the floor plans, the elevator well, the halls, the stairs, and the toilet rooms, each of which will require a given amount of space; and for economy of construction it is desirable that the various floors be made duplicates as far as possible, while for some of these features duplication is generally an absolute necessity.

The elevator shaft should be 1 foot larger in each dimension than the car, and should be placed at the center of the building or as nearly so as possible. The halls depend upon the size of the building to a certain extent, but for the usual $25' \times 100'$ or $50' \times 100'$ building they must be made as small as possible. The hall on the ground floor should be as direct as possible from the entrance to the elevators, and about 8 feet wide, with a space in front of the elevator the size of the well. On the upper floors, 3 feet 10 inches will be wide enough for the main halls, while 4 feet in front of the elevators will give ample room for the accommodation of passengers.

135. The stairs are used only occasionally and are in no sense to be considered as an ornamental feature in strictly utilitarian buildings. Occasionally, when the entire second floor is occupied by the offices of a large insurance or banking corporation, it is desirable to provide a grand staircase leading up to it, but the money that such a feature costs could certainly be spent to better advantage in other parts of the building. Under ordinary circumstances, a stairway 2 feet 10 inches wide is ample for ordinary purposes, and it should be placed at the end of the hall, or some other out-of-the-way place, and be made as plain as possible.

The toilet rooms should be placed either on a light well

or on an exterior wall of the building, and must have good light and ventilation. As, frequently, there are tenants who desire to use an entire floor in the building, the toilet rooms should be so placed as not to interfere with the removal of all the partitions.

136. The economical depth of the offices is an item that must receive the closest study, the depth varying with the height of the ceilings, the width of the street, and the size of the windows. Except for special purposes, an office should not be more than one-third greater in depth than in height, and 16 feet is about the average limit, as any depth beyond that does not materially increase the rental value of the average office. A good standard size for an office is 150 square feet, and if the plan shows the room about 10 ft. × 15 ft., we have this standard size. Any tenant desiring a larger office can easily take down the partition and double the area. Where the light is particularly good, offices may be larger, especially where the building is large or the business requires it. This consideration of office depth limits also the useful size of a lot, as may readily be seen. There is a point where the extra size can only be used for court space, or in uselessly increasing the size of the offices.

137. In Figs. 99 to 104 we make practical application of the principles above set forth. In Fig. 99 we have the plan of one of the upper floors of an office building designed

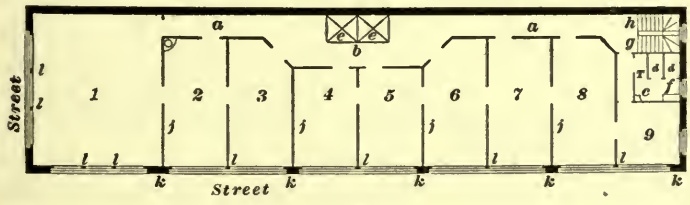

FIG. 99.

for a 25′ × 100′ corner lot and constructed on the skeleton-frame system, explained in *Architectural Engineering*.

The elevators *e* are here placed in the center of the depth

of the lot, against the inner wall or dark side of the building. The hallway is 3 feet 10 inches wide at *a*, but in front of the elevators it widens out to 4 feet at *b*. The stairs descending at *h* and ascending at *g* are, as before stated, seldom used in a multi-storied building, and consequently are located in the rear of the building, entirely out of the way, as is also the toilet room *T*. According to our rule, we would require for the nine offices on such a floor, two water closets *d*, *d*, one basin *f*, and one urinal *c*. All the offices in such a building are light, as the windows open directly on to the street. The widths of the offices are determined largely by the construction of the building (or, vice versa, the construction may be fixed by the predetermined extent of office areas, as explained in *Architectural Engineering*), and the partitions *j* are in fixed positions and cannot be changed in any floor, as they come in line with the columns of the steel construction. These columns are, of course, concealed in the piers *k*, which are the only masonry lines on the front of the building, except the covering for the girders between stories. An immense window area is thus obtained, which is broken only by the small cast-iron mullions *l*, and thus the maximum amount of light is secured for each office.

138. In Fig. 100 we have a lot of the same size, but in the center of the block instead of on a corner. It is, therefore, necessary to make a break in the side of the building,

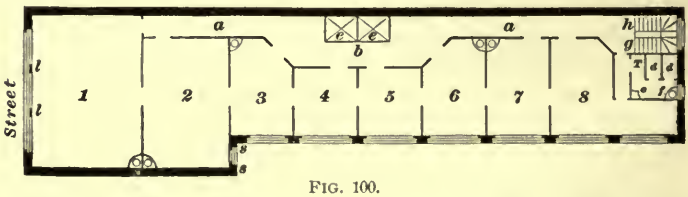

FIG. 100.

as at *s*, *s*, to form a light shaft, but the rooms on the lower stories will be quite dark at all times, as we can afford to reduce our building only 5 feet in width in order to secure this shaft, and special attention must be given to the convenient and liberal arrangements for artificial light in these

lower stories, to compensate for the lack of sunshine. The reduction in the width of our building by the encroachment of our light shaft will also change somewhat our system of construction. All the rooms on the light shaft in Fig. 100 should be wider than in Fig. 99, in order to bring their average area up to the standard. This reduces the number of offices on each floor and correspondingly cuts down the rental income of the building. But as a middle-block lot is not as valuable as a corner lot, and as a middle-block building has but one front to be built, while a corner building has two street fronts, it is not to be expected to derive as large an income from an interior building as from a corner building, as there is not nearly as much money invested, and these difficulties therefore equalize themselves. The hallway at *a* and *b*, the elevators *e*, the stairs *g*, *h*, and toilet room *T*, and the fixtures *d*, *c*, *f* are similar in size to those shown in Fig. 99.

139. In Fig. 101 we have a plan of a building designed to cover a corner lot 50 ft. × 100 ft. In this case the elevators are placed towards the front of the building, thus shortening the length of the wide hall on the ground floor and economizing floor space for offices.

On the east side of the building is arranged a court *D* through which light is secured to the offices on that side; as the court is left open on the south, considerable sunlight will enter it during the middle of the day. The space *b* in front of the elevators *e* is of liberal dimensions, which

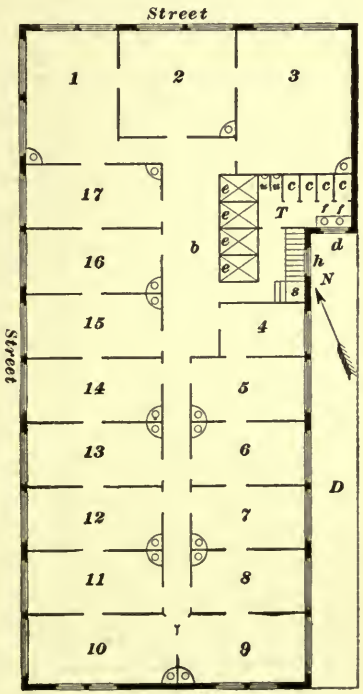

FIG. 101.

allows passengers plenty of room to stand while waiting for a car, without interfering with the entrance to, or egress from, the adjacent offices. The stairs *s* and the toilet room *T* are placed behind the elevators and in a space that would be of little value for renting purposes, owing to the insufficiency of the light. The windows *h* and *d*, while not giving much light, will be invaluable for ventilation. As there are seventeen offices on this floor, three of which are unusually large, we provide, according to our rule, four water closets *c*, two urinals *u*, and two basins *f*, as shown on the plan, besides a basin which is placed in a corner of each office, with the exception of room *4*. If the plan was to be utilized for a lot in the middle of a block, the only alterations to be made would be to arrange another court on the west side of the building and duplicate the plan as here designed for the east side, except that two extra offices could be arranged in the space occupied by the elevators, toilet room, and stairs.

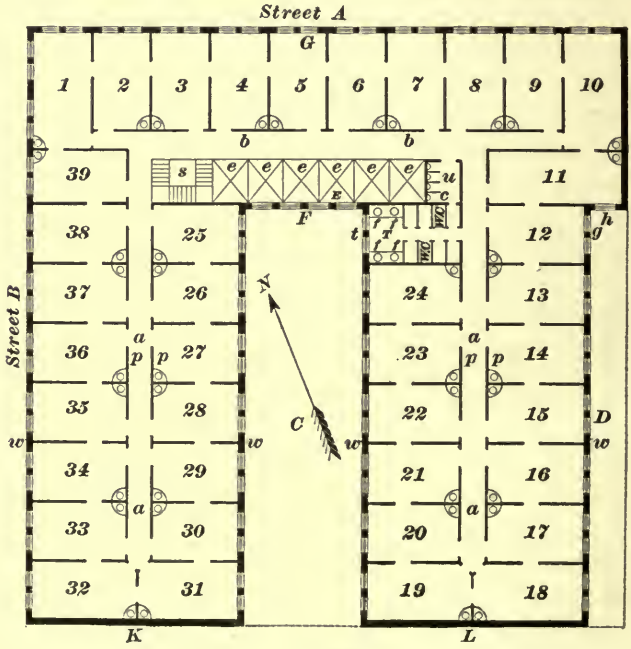

FIG. 102.

140. In Fig. 102 we have a plan for a building 100 ft. × 100 ft. on a corner lot, with a large light court *C* in the center, and a smaller court *D* on the east side. In proportioning these courts, in all cases and especially in a structure of this size, it is very important to have them as large as possible, in order to secure an abundance of light and air, and at the same time they must not be so large as to waste space that would otherwise be available for renting. In this case, our building is 100 feet wide from east to west, and we can allow about 15 feet for the depth of each of the offices, so that from east to west we have four offices of 15 feet each, or 60 feet; four walls *w* of 1 foot each; four partitions *p* of 6 inches each, and two halls *a* of 4 feet each, or a total of 74 feet of actual building; thus leaving 26 feet of the width which can be used as light courts. If we make the central court 19 feet and the east court 7 feet, we have arranged to use the allotted space economically, and can now proceed to divide up the offices.

141. The six elevators *e* are arranged along the main corridor *b*, and the offices opposite them, along the main street front, are designed 16 feet deep, to bring their floor area up to the standard, as they are less than 10 feet in width; the corridor *b* is 5 feet 6 inches in width, and the elevator shaft is 6 feet 6 inches deep, so we have, with the thickness of the partitions, 29 feet from the inside of our front wall *G* to the wall back of the elevators *e*, which gives us the inside line of the light well at *E*. After subdividing the wings *K* and *L*, we find we have to provide toilet arrangements for thirty-nine rooms. This will require eight water closets *W C*, four wash basins *f*, and four urinals *u*. The closets and basins are placed in the toilet room *T*, and are ventilated through a window *t*, while the urinals are placed in an apartment by themselves, and are ventilated into the main toilet room *T* through a small window *c*. The stairs *s* are conveniently placed and occupy space that would be of little value for renting purposes. The toilet room in this case is not located in the space occupied by room *11*,

which would correspond with its position in Fig. 101; as shown on the plan the window *h* is very close to the office window *g*, and by placing the toilet room in room *11*, the rental of room *12* would be depreciated. Another objection would be that the single window *h* would not be large enough to sufficiently ventilate a room containing so many plumbing fixtures as are shown in *T*.

142. If this building were in the middle of a block instead of on a corner, two solutions to the problem would present themselves, according to circumstances. If the building were to front on street *A*, the best thing to do

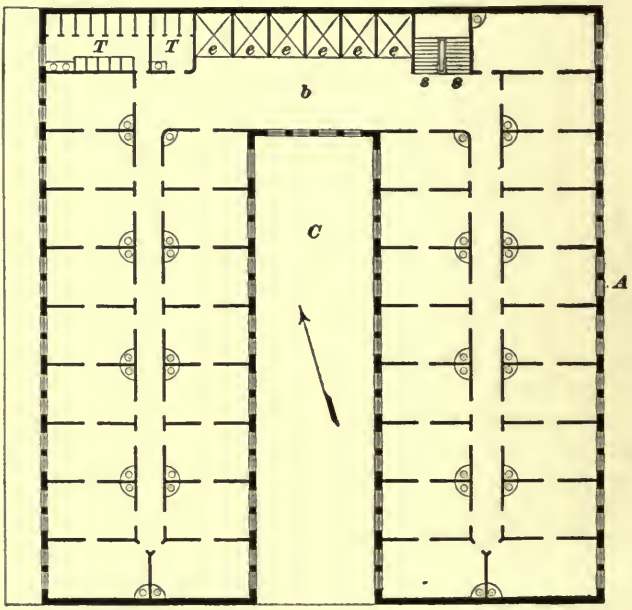

FIG. 103.

would be to design, on the west side of wing *K*, a court similar to court *D* on wing *L*, and keep the general arrangement precisely the same as before. But if the building were to front on street *B*, the most satisfactory plan would be that shown in Fig. 103.

143. In Fig. 103 we have a light court *C* running $22\frac{1}{2}°$ east of north as before, but in this case it is parallel with the front of the building, which is at *A*, and all the office windows face practically east or west. The elevators *e* are against a blank wall, and the corridor *b* in front of them is well lighted through the windows facing the court *C*. The toilet rooms *T*, *T* and the stairs *s* bear the same relative position to the elevators as they did in Fig. 102, but are changed over to the dark side of the hall, so that the lightest portions of the building may be utilized for renting.

144. We have not illustrated a building with a frontage between 50 feet and 100 feet, as any size between those limits would present no new feature or even advantage over the $50' \times 100'$ plan, except in increased light courts and a slight enlargement of the offices.

145. The halls in these buildings depend for their light almost entirely upon the transom sashes over, and the glass panels in, the office doors; therefore, the upper panel of the doors should always be of ribbed or other translucent glass, and a liberal transom sash (hinged or pivoted) should be placed in each doorway. The passages may be rendered lighter by placing a range of sash openings in the partitions in line with the transom sashes over the doorways.

The courts and light shafts should be faced with white or gray enameled brick, to insure the reflection of the maximum amount of light into the offices. The halls, corridors, and toilet rooms should have tile or cement floors, while the offices should be floored with the highest grade of quartered Georgia-pine flooring at least $1\frac{1}{8}$ inches thick.

In buildings where the business carried on is of a character that requires the receipt or delivery of large cases of goods, it is necessary to provide, in addition to the regular service, a freight elevator, whose size and capacity cannot here be given, as it would depend entirely upon local circumstances.

146. The exterior of the modern office building is governed almost entirely by the construction, the main

object being to secure all the light possible and create a design that will reflect credit upon the projector, while it neither increases the expense nor interferes with the utilitarian points of the construction. In skeleton-frame buildings the reveal of the windows is necessarily slight, while heavy projections, such as cornices and string-courses, are almost impossible, but the vertical lines may be divided by strongly emphasized horizontal courses, and the plainest structure may express architectural character of the strongest kind by the judicious arrangement of a few exterior details.

The design of the elevations of a building should express three general divisions: the *basement*, the *superstructure*, and the *roof*, or, if in columnar treatment, the *pedestal*, the *column*, and the *entablature*. This application of the term "basement" is not in the same sense as its general acceptance; namely, that portion of the building which is below the ground line; but, as applied to the elevations, the basement of the building is the lower division upon which the superstructure appears to rest. The basement may be subdivided into several stories, but the treatment of the elevation must be such as will group them so that the eye will consider them as one mass. This will be more clearly understood by reference to Fig. 104, where *A* may be considered the pedestal, *B* the shaft, and *C* the entablature. In some buildings the basement is built of rock-faced ashlar, which gives a bold and sturdy expression to it, while the superstructure is rendered lighter by finishing it with a clean-cut stone. The roof or cornice should be carried up to give a fitting crown to the whole structure, and should contain the stories assigned to it, without having the internal effect of an attic or garret.

In many office buildings there are several stories below the street line, consisting of the basement floor (which is the first story below the sidewalk), the cellar, and often several subcellars. When structures have to be erected to such great altitudes as are many modern mercantile buildings, it is frequently necessary to excavate 50 and sometimes even 60 feet to secure a sufficient and stable foundation.

FIG. 104.

147. The conditions of the soil, bed rock, or sand beneath a building frequently make it necessary for the architect to entirely change his foundation plan and general system of support. It is, therefore, not only desirable, but very often absolutely indispensable, that the architect should have borings made on the site of the proposed building, so as to determine the character of the strata. This question of foundation is a vital one, as on it depends not only the permanence and durability of the structure, but also, very largely, the cost, convenience, and arrangement and economy of administration. It is down among those piers and walls of the foundation that much of the machinery for water supply, elevator service, electric lights, and steam heat will be located; the necessary storage room for coal and other supplies, with room for extra pieces of machinery, tools, and a workshop, must also be considered; and, unless conveniently located, much time may be lost or extra help required to satisfactorily conduct the work of the building.

148. The mechanical devices resorted to in building foundations under special difficulties are described in *Masonry* and in *Architectural Engineering*, but the consideration of just what means will be required to accomplish certain ends must be given full attention at the time of the planning of the first floor and basement. Whether the building is to be of skeleton-frame or solid-masonry piers, the location of the foundations of these piers must be determined before the upper work on the building is laid out, in order to concentrate each load and weight proportionately. If examination has proved that the soil upon which the building is to stand will carry a load of $2\frac{1}{2}$ tons per square foot, then the ultimate load in tons of each column, pier, and wall must be divided by 2.5 in order to determine the area necessary for each part of the foundation. The greater the accuracy of these calculations, the more stable and durable will be the building. Every building will settle somewhat, and the great problem for the architect is to proportion its parts in accordance with the sustaining value of the soil, so that each

and every part will be subjected to a uniform settlement. The irregular settlement of a large building, even though the variation is slight, will cause the plaster to crack, doors and window sashes to bind in their frames, or be opened or closed with more or less difficulty, floors to sag out of level, and, in many cases, the pipes which are carried throughout the house for gas, water, or steam to be *trapped* and even broken. The uniform settlement of a building is, therefore, a matter of the gravest importance, and demands the closest attention.

149. In nearly all structures, the ground floor, or the one next to the street, is of the most importance, and having arranged this to suit the requirements of the problem in the planning of rooms and the construction of the foundation, we proceed to the floors above and subdivide them according to the necessities of the case. This subdivision may probably require us to make changes in the arrangement of the first floor, and these changes may entail others in the foundation; so that the least alteration in the arrangement of any of the plans must be duly considered with reference to its bearing on the others.

It is customary in the offices of the best architects to lay out the first-story plan according to the requirements of the utilitarian purposes of the building, and then to lay over this drawing a sheet of tracing paper and draw the basement, or foundation plan, arranging the piers, columns, and interior walls under the points which require support. If some of these points of support occur upon soft or otherwise undesirable portions of the ground, we may have to resort to the system of cantilever foundations, or so change our first-story plan as to bring the load over a more secure area. In either case an alteration of the foundation plan will be necessary, which may cause frequent tracing and retracing before the plans can be made to meet the requirements of utility, strength, and beauty.

150. Having arrived at a satisfactory arrangement of the foundation and first-story plans, we now proceed to the

second story, and having subdivided this into rooms and corridors, stair wells, and elevator shafts, as required by the problem, we discover that in order to secure rooms of the required size and proportion, and at the same time keep all partitions over one another, we must make some changes in the first-floor plan. Before we do this, we must study how such changes will affect the foundation plan, as that, too, will require alteration. In this rearrangement we have three plans to bear in mind, instead of two, and when the point is settled, and we start the third-story plan, the same difficulties may have to be settled again and again. Thus, when each floor has been satisfactorily planned, proper consideration must be given to every structural detail; this is an absolute necessity, as each structural feature is dependent more or less upon the other. A building, like a fabric, must be well and compactly bound and knit together, each and every part must be duly proportioned to the work it has to do, and strength, durability, and beauty must be present before it can be considered a successful architectural conception. This success can only be secured by assiduous study and constant perseverance.

While the plans have been in progress, and frequent alterations have been made, we have been constantly considering the effect to be produced in the elevation by each of these changes, and, consequently, have in mind a general idea of how the elevation or elevations will appear. This mental picture will include the general treatment of each of the portions or divisions of the facade referred to as the basement, superstructure, and roof, and we will be enabled to draw a rough freehand sketch of it, from which we can "work up" our scale elevation. The same rule of practice will be used as in the planning, and by constant rearranging of parts, our elevation must be, not fitted to our plans, but made a part of them. The moving of a partition or the changing of a column may require the rearrangement of all the plans, but this must be done, whenever necessary, to accomplish the desired end.

151. Having completed the elevations, we turn our attention to the roof. If it contains several stories, provision must be made to light them by dormer-windows, which require to be shown in the floor plans, and having decided on the treatment of the roof in design, we have then to deal with the covering, so that the roof will be not only water-tight, but strong, durable, and effective.

Whether this roof is to be of wood, covered with some selected roofing material, or whether it is to be of iron frame, filled in with fireproof blocks, the problem of proper drainage and watershed will be the same.

Ample provision must be made to carry away all the rain or melted snow water that may accumulate upon the roof, and proper slopes be given to shed this water in the direction of the gutters which feed the leader lines. The amount of slope necessary for this purpose is very slight, but consideration must be made for extremes, and the pitch of a flat roof should always be in excess of the requirements. The necessary amount of pitch is also governed very largely by the materials used, as tile, slate, shingles, and similar materials which constitute a roof covering of several pieces, and require a pitch much steeper than do tin, tar, asphalt, and other homogeneous materials which constitute a roof covering practically of one piece.

This is all explained, however, in *Roofing*, and the only bearing the subject has here is in connection with its effect on the design of the elevation. In an office building such as is here described, the roof may form an important part of the design of the front elevation, in which case the covering material may be of tile or slate, and the question of color will be taken into consideration when the architect studies his design, forming thereby another element whose harmony or contrast will materially count in the general excellence of the composition.

There are many cases where the roof division of the elevation may not show the real roof at all, but be simply the upper part of what is really the front wall, treated in design to group with the roof in effect, as is the case with the socalled Mansard

roof, where a slight inclination from the perpendicular is given to the upper part of the front wall, and the windows therein inserted as dormers. The front is then covered with slate or tile and forms a part of the apparent roof, while the real serviceable roof is nearly flat, and usually covered with copper, tin, or tar and gravel.

152. Chimneys have frequently been made a prominent detail in the design of the roof, especially in those periods of the Renaissance style where the Gothic forms had not entirely disappeared. This is dependent, of course, upon where the chimneys occur on the roof plan, as they are sometimes too far back of the facade to be visible from the ground. In the periods referred to, the open fireplace was becoming a popular feature in all rooms, especially in residences, and as each fireplace required a separate flue, the chimneys were, in consequence, very numerous and very large, and played a prominent part in the establishment of character and variety to the roof.

It is seldom that chimneys are either large or numerous in an office building, as the steam-heating plant in the basement requires but one flue, and it is seldom desirable to have open fireplaces in offices, unless they are to be occupied by a club or association. If such is the case, however, the architect must clearly show on his floor plans just where these fireplaces are to be situated, and must provide ample space in the chimney breasts for all the flues to be carried up to the roof in as direct a line as possible.

Even where fireplaces are provided, steam generally furnishes the heating element of the building, and the architect must provide in his plans a proper place for each radiator, and take into consideration, when he is arranging his subdivisions on each floor, that the steam-heating pipes should extend in a direct line from the cellar to the top floor, and that a clear way provided for them will prevent much subsequent trouble and difficulty in running the pipes. The radiators must be as near the rising lines as possible, and while their efficiency is greater when they are on the cold side of

the room, they must be so placed as to temper all the cold air as well as keep it in circulation.

153. Hospitals, schools, colleges, theaters, and all places of public assemblage require, in addition to the foregoing conditions which govern the plans, a careful consideration of the matter of ventilation.

The system of ventilation to be used must be decided early in the progress of the drawings, as it may be necessary to leave vent flues in the walls and provide an arrangement of rooms that will be conducive to the perfect circulation of the air.

154. Modern buildings are illuminated after nightfall by either gas or electricity, and, as the latter is subject to some uncertainty of action, it is usual to supplement it with proper fixtures for gas in case the electric lights fail to work. Gas fixtures require that the entire building be piped, and, as there must also be water and waste pipes, as well as electric wires, it is the usual practice to provide a *well*, or *shaft*, built of brick, next to one of the principal walls and extending throughout the building. This shaft contains all these pipes and wires, and besides preventing the cutting of floors and ceilings at numerous places to permit the pipes to pass through, it renders any damage, leak, or other difficulty easy of access and repair, as the shaft is open on each floor through an ordinary door.

155. Where a building requires a mechanical equipment, it is usually situated down among the piers and walls of the foundation; in large cities it is customary, in many cases, to hire or rent the steam and electric power from companies incorporated for that purpose. These companies bring the steam pipe or electric wires into the building in the same manner as do the gas companies, and the owner carries the steam or electric current throughout the building by means of his own pipes or wires, built in when his structure is erected. In cases where the owner is desirous of keeping this part of his service under his own control, it is necessary to provide in the basement of the building, a boiler

room, an engine room, and a dynamo room. In hotels there may also be required a freezing room, or ice-machine room, where cold brine, or other fluid, may be pumped through pipes to refrigerators and wine cellars, while in hospitals such machinery is used to supply cold air to the wards and operating rooms during warm weather.

This machinery must not rest on any of the framed floors of a building, especially if it is to be of the skeleton-frame type, as every vibration or sound will be carried to every part of the structure by the ironwork. A separate foundation should be built for each engine, pump, dynamo, etc., except under special circumstances or where the engine and dynamo are combined on one bedplate.

CHURCHES.

156. The city residence, the country residence, and the office building are the three most frequent problems in architectural design, with the possible exception of church building, and though it is with ecclesiastical buildings that architecture has been most intimately identified in past ages, no definite system can be laid out for the procedure relating to their design.

Next to a thorough comprehension of religious architectural history, there is probably no greater assistance to the church designer than a complete understanding of all the details of its service. In church building, architectural design might be called *applied architectural history*, as the history of the Christian church is a history of architectural advancement, and no style of architecture could ever be more appropriate to church work than the style which was developed when Christianity advanced.

The different denominations of the Christian church require different arrangements of plan to suit their different forms of service, and the details of their designs depend upon the history of the development of their peculiar forms of faith.

Appropriate church architecture, therefore, includes nearly every style except the Classic Revival, but the style selected for an ecclesiastical edifice may none the less be decidedly inappropriate, as each of the denominations or sects of the Christian religion is more or less intimately connected with a certain style of architecture. The Romanesque and Gothic styles were developed in cathedral building during the ages when there was one united Christian church—the Catholic Church—but with the period of the Renaissance there was a division of the church, and though there were many Roman Catholic churches built in the style of the Roman Renaissance, they were not as architecturally successful as those in the Gothic and Romanesque designs. In designing a church, it is necessary to be familiar with the forms of its ceremony, the history of its foundation, and the general character of its government. The Roman Catholic Church and the Church of England, or, as it is sometimes called, the Episcopal Church, usually have their edifices built in the form of a cross, as explained in *History of Architecture*. The Presbyterian, which was the recognized English church in 1648, and the Methodist, which was a secession from the Episcopal in 1727, have their edifices generally planned as simple rectangular lecture rooms which are devoid of the architectural adjuncts peculiar to other forms of service, the buildings being so arranged that the preacher or pastor can address the entire congregation from a platform or pulpit.

ARMORIES.

157. Another form of modern building in which the requirements of the design are more or less predetermined, is the armory or drill hall, which is erected in cities and towns for the purpose of drilling and quartering the volunteer or citizen soldiers known as the militia.

The specific problem in a plan of this class of building consists in the provision of a drill room large enough for the military evolutions of a body of men which may range from two hundred to two thousand; rooms are also required which

must be sufficiently large to enable each company or subdivision of the regiment to form and prepare for drill, and such rooms require to be provided with individual lockers, or small closets, in number equal to that of the company. Arrangements must be made for the proper heating, lighting, and ventilating of the structure, and provision must also be made for a rifle range, janitor's rooms, coal storage, etc., together with such other conveniences as the circumstances may require. Besides the specific problem, there is a contingent problem which arises when the men require to be quartered in the building; this may occur either during the time of an insurrection or riot, or when the armory is being besieged by a mob of rioters, or after the regiment has returned from service and is quartered in the armory to await discharge.

Such conditions require not only that room be provided for the storage of blankets and bedding, with a kitchen for the preparation of meals, but that the walls shall be of sufficient strength to withstand the force of an attack, and that no areas, coal slides or other exterior pockets shall be formed, wherein the rioters might explode dynamite or bombs to the injury and displacement of the walls. The corners and projections of the building should be protected by turrets and towers, from the windows or roofs of which the besieged can shoot in at least three directions. Telegraph, telephone, and electric-light wires, if used, should enter the building through an underground conduit, so that communication cannot be interfered with by the besiegers, and the wooden parts of the building must be so protected that the mob cannot throw inflammable material upon it and set it afire. On the inside, every preparation must be made not only for vigorous defense, but also for confinement; therefore, in addition to the kitchen, there must be storerooms for food, while in a remote part of the building there should be a room where the sick and wounded may be cared for. A *postern*, or gate, more or less concealed on the outside of the building, must provide a means of egress and ingress for spies and messengers. Complete fire apparatus, including a quantity

of hose and a pump to produce high pressure, should also be arranged, as in the event of a siege the city fire department would be powerless.

We can discern a similarity of circumstances, and consequently the appropriateness of the style of the medieval castle to the modern armory or military storehouse for arms and ammunition.

EDUCATIONAL BUILDINGS.

158. Colleges, schools, seminaries, and other educational institutions are frequently designed in the Elizabethan style, though the specific course of instruction for which the building is erected will, in many cases, dictate a different style of treatment. The fact that during the Elizabethan period so many educational institutions were erected makes this style singularly appropriate to such a purpose in all English-speaking countries; but, again, the Renaissance, in general, is typical of an age of education and of mental advancement.

The period of the Renaissance is prominent in the world's history as the age during which the people emerged from the darkness and superstition of the middle ages to enlightenment and freedom. Previous to this era, none but a member of the clergy was able to read or write, but after its advent, schools were established everywhere, and systematic education, for the first time, became a part of the training of the young. Hence, in France, Germany, Holland, and Great Britain, we see the schoolhouse erected in the style of architecture that marks the early stages of Renaissance. Colleges devoted distinctly to the pursuit of classic studies are frequently erected in a strictly classic style, tempered more or less by the local peculiarities of the country in which it is found. Girard College, as shown in Fig. 134, *History of Architecture*, is an example of this, while the early style of Elizabethan schoolhouse prevails in England and Scotland at the present day.

159. Art galleries, museums, and libraries, also being institutions of an educational character, usually partake of

the classic style of design for the same reason as do the colleges, though they are sometimes seen in the Gothic style, purely for local reasons.

Venice having been a great art center for many generations, and possessing a style of Gothic peculiarly her own, it is not strange that many modern buildings should pattern after her school. Then again, during the Gothic Revival period in England, all buildings were erected in the style which was then fashionable, and we find all periods of Gothic art revived and exhibited in the facades of the educational buildings of this period. It therefore follows that there is no fixed law governing the style of architecture appropriate for a building, it being only necessary that the purpose for which the structure is erected should be evinced in the design, and as certain styles of design have been intimately associated with certain institutions, it renders those styles desirable factors in giving an expression of *character* to the edifice.

Proportion of parts and outline of mass are also potent factors in determining this expression of character in a building, but unless these are combined with a correct interpretation of an appropriate style of architecture, they are sure to fail in conveying to the mind the desired idea.

PUBLIC BUILDINGS.

160. Government buildings, such as capitols, city halls, court houses, etc., are nearly always designed in the classic style, although exceptions, generally due to local influence and fashion, may occur, such as the British Houses of Parliament, shown in Fig. 130, *History of Architecture.* The classic style is appropriate to such structures principally because the history of the modern system of civil government begins with the systems of Greece and Rome. The modern capitol or city hall is the seat of government, where laws are enacted that differ only in detail and not in principle from those promulgated by the government of the Cæsars. The court house is the structure where these laws

are interpreted under discussion, and, as an adjunct to the seat of government, its architecture should be of a harmonious style. A prison or jail is frequently built in connection with the court house, and the latter must, therefore, be altered in style, in order that the buildings may appear as one structure, while at the same time each part shall show its specific purpose. The prison, being an edifice for the forcible detention and confinement of prisoners, naturally reminds us again of the embattled and curtain-walled environment of the feudal castle, and, indeed, such a style of architecture is decidedly appropriate to such a building, but most inappropriate for a modern court house.

It is, therefore, necessary to design our court building in a style that will express the dignity of the law and yet not be in total discord with our feudal Gothic jail. We, therefore, execute the design in the Gothic school of the period that prevailed just previous to the reign of Elizabeth, in England. We find a precedent for this in the numerous town halls or guildhalls that were erected in Holland and Belgium at this time, many of the details of which found their way and became prominent features in the Elizabethan school of design.

Town halls, as distinguished from the more dignified epithet of city halls, may also, on account of their precedent in the low countries, as Holland and Belgium are sometimes called, be appropriately designed in the Gothic style, but, as said before, the seat of government in a large city demands a dignity of treatment and a boldness of design thoroughly in keeping with the importance of its purpose. These examples are sufficient to show that a proper amount of consideration must be given to historical value, as well as to general architectural treatment, in the design of a building, and where an owner desires to erect a building in a particular style which is inappropriate to the purpose for which the structure is intended, it is the duty of the architect to explain to his client the incongruity, and endeavor to instruct him in the principles of expression, so that he may have a better conception of fitness and propriety.

SPECIFICATIONS.

INTRODUCTION.

1. Among the important factors entering into the process of building, the **specification** is justly considered the first. The ability, therefore, to write a definite, particularized, and complete statement of the material, labor, and methods of workmanship demanded in a modern building, is certainly, to architects and builders, a desirable and much-prized acquirement.

The drawings are a reproduction of the architect's design in scale projection, while the specification should be a clear, concise, and, withal, comprehensive statement of the material and methods required to carry the design into execution; when both drawings and specifications are combined, the architect's idea is presented in technical language that may be readily understood by the builder and his artisans.

The writer of a specification should have the design clearly and accurately—fully and in detail—mirrored in his mind, and should, at the same time, possess such definite knowledge of the methods and materials to be employed (varying, of course, according to locality, season, and other circumstances) as to be able to express his conceptions—clear and exact in his own mind—in language at once lucid and concise. Not only should the purpose be well considered, but also the order of treatment of the subject matter of the specification. The instructions as to general principles

should comprehend the entire work covered by the contract. The arrangement of the specification should, as nearly as possible, follow the order in which the work is to be executed. The description of materials and labor should be clear, definite, and particularized; while the wording should be so precise as to leave no room for doubtful interpretation. Uniformity in the use of words, and the avoidance of more than one term to mean the same thing, tend materially to make the specification clear and explicit at all points.

2. Terms.—Some terms in specifications call for definition or explanation. The word *provide*, used alone, is sufficiently definite, when applied to labor; but, when applied to materials, the phrase *provide and set*, or *provide and erect*, should be employed. *Supply* is a term generally used in connection with materials. *Proper*, or *in a proper manner*, should, when speaking of the execution of work, be taken to mean that the work is to be performed in a manner equal to any other work on the premises; but these terms are to be used as sparingly as possible. *Best* should be accepted in its literal sense; and, in connection with materials, construed to mean that nothing better is to be had; while, referring to labor, it should be taken as meaning the most skilled workmanship available. *Prime cost*, a term generally employed in connection with alterations, deductions, or extras on the work, should be clearly defined to show whether it means the list or catalogue prices, without trade discount; or these prices, without discount for cash; or, again, cost price, with retailer's profit, and charges for cartage and delivery added. *Average* should be avoided as much as possible, for words of such indefinite meaning very often give rise to grave misunderstandings. *Sizes* should be explained to mean either *rough*, *out of*, or *finished*. *Attendance*, or *personal supervision* by the contractor, should be exactly defined, and the amount of labor, as well as the extent of responsibility he assumes, fully understood. *Watching* and *lighting* should be so precisely stated as to make it clear whether watching and lighting are provided for the contractor's own work, or

for that of the subcontractor; or, again, whether there should be a watchman by day as well as by night. But under these terms should also be exactly defined the use of lamps and the character of any especial lighting, to be set up either on the premises, or excavation work in the street, together with special attendance on fires in boilers, etc. *Obtaining permits* is a term that should clearly set forth and should state whether the contractor is to pay the fees charged for permits —whether, for instance, he is to pay for water used for construction purposes on the premises, which is charged for, in some of the larger cities, at the time the permit for tapping the street main is issued.

Under the term *facilities* should be clearly stated the extent of the privileges required; likewise, the purpose of any facilities demanded for reasons other than the inspection of the work. *Provide scaffolding* is specific enough, when scaffolding is intended for the contractor's own purposes. In the case, however, of special scaffolds or platforms, required for other purposes, it is but fair to determine beforehand their location and extent. *Débris* and *rubbish* are generally mentioned in connection with clearing the building of all refuse matter, such as shavings, old mortar, etc., after the artisan has entirely completed his work, or when, at the completion of all other inside work, the joiner commences the interior trimming and finishing. In cases, however, where temporary privies are put in for the accommodation of workmen, the removal of these and all night soil should be specified, separately and distinctly, and not included under *débris* and *rubbish.*

Cast iron, *wrought iron*, and *steel*, to be employed in the construction of a building, must be tested for quality and strength. Not only must the tests be specified, but statement should be clearly made as to who shall assume the burden of paying for these tests, whether the material passes the test or not. It should likewise be stated whether the material in question is to be tested at the foundry or rolling mill, or at the building itself, or at both places. In the matter of *drain pipes*, the tests should be defined, and

declaration made as to whether the water, peppermint, mercury, or smoke test be employed for the purpose.

3. Among other points, often overlooked or forgotten, may be mentioned the placing in accessible positions of all traps, pipe connections, cisterns, etc.; the possible necessity of driving sheet piling; the shoring up of embankments and walls of adjacent buildings; the pumping of water from excavations; and the selection of stock, or market sizes and shapes for the several kinds of building material; but, in respect to these and other points not mentioned here, much must be left to the judgment of the writer of the specification, guided, as he must be, as well by the circumstances of the time and place selected for building operations, as by the other concomitants of the case he may have to deal with.

The happiest results in the writing of specifications might, perhaps, be achieved, were the writer to place himself in the position of his client, taking direct personal interest in the judicious expenditure of the moneys at his client's disposal for investment in the building under consideration; also, to take the contractor's point of view and select the most suitable and available materials for construction; and, finally, as clerk of works, to get from the workmen conscientious, intelligent, and accurate labor.

FORM OF SPECIFICATION.

HEADING AND GENERAL-CONDITION CLAUSE.

4. To facilitate the writing of specifications, and to assist the student in this direction, the system adopted and incorporated in the appended copy of a typical specification has been followed. The specification is distinguished from the general matter by being printed in smaller type. All special work or information, not incorporated in the specification for an ordinary building, is printed in Italics; and all dimensions enclosed between parentheses are provisional, and subject to

changes demanded by different classes of work or localities. Should the masonry, carpentry, or the work of any other of the principal trades, be made the subject of a separate contract, the specification for each contract should be distinct, preceded by a heading and general-condition clause. The heading is as follows:

SPECIFICATION FOR A FRAME DWELLING.

Specification of the materials and workmanship required, and to be furnished, for the erection of a *frame dwelling* to be constructed for *Mr.*.....

at.....*in the City of*.....

County of.....*and State of*.....

in accordance with drawings and this specification, and under the supervision of

.....*Architect*..... *Address.*

.....*Date.*

5. The general-condition clause, which should precede the specific description of the work and material required by every specification, is introduced as a precautionary measure, to cover all those details and conditions that are likely to arise in the progress of building erection, and that cannot be foreseen and provided for under the classified headings of the different parts of the specification.

The wording of this clause is very important, as, in the event of a lawsuit over the contract, the provisions of the general-condition clause are likely to become the basis of over half the arguments of the case.

It is usually stipulated in the contract that the general-condition clause, as well as the whole specification, forms a part of the agreement, equally as binding as the contract itself. Those general conditions are affixed to the specifications, so that each and every builder who bids on the work will thoroughly understand his risks and responsibilities, and provide accordingly in his quoted price, so that when he comes to sign the final contract, he will be unable to claim that he did not understand the requirements of the owner, and thus be compelled to make an addition to his price to provide for the stipulation afterwards inserted.

Many of the lawsuits that occur in building transactions are through misunderstandings brought about by omissions from, or an obscure statement in, the general conditions; hence, they should cover all possible contingencies that are likely to arise, and provide for them in such clear and concise language that there can be no possible room for doubt in regard to their meaning. It would also be advisable to leave a few blank lines at the end of the general conditions, so that special stipulations can be inserted should occasion demand it.

Care should be exercised to see that the general conditions are included in the contract, that is, that they may actually be a part of the formal contract; or, as is usually done, form a part of the specifications. When they do thus form a part of the specifications, especially when they are printed on separate sheets and attached thereto, it should be expressly provided that they are to form a part of the specification, and as such are included in the contract. This precaution, though possibly unnecessary, removes all room for subsequent argument.

6. All practising architects who have to deal with their clients' bills, appreciate the necessity of providing in the contract that all transportation shall be prepaid. The material dealers and others furnishing goods that are to be sent from a distance, are often inclined to send them by express, and charge the expressage to the owner; and even where there is no intention of compelling the owner to pay transportation, goods are often sent by freight at the owner's expense, and he is supposed to make a back charge on the shipper's account. This practice causes unnecessary bookkeeping for the architect or owner, and should not be tolerated when it is possible to prevent it. It is also advisable to insert a provision in the general conditions to the effect that, before any part of the work can be sublet, the written consent of the owner shall be required. The architect often reserves this right to himself on the ground that, being more familiar with the operation of building, and the standing of

the various contractors, he is more capable to judge of the fit party than the owner. This is not, however, always a wise stand for the architect to take, because it tends to destroy his position as a disinterested adviser, and gives libelous contractors an opportunity to make insinuations of dishonest partiality towards certain mechanics.

The architect would do well to hold his position distinct and separate from the owner, who is one of the contracting parties. In doing so, he will establish himself as an expert judge, rather than the owner's agent, which is always advantageous, and adds dignity and weight to his decisions.

7. The architect should observe the individual workmanship of the men employed by the contractor, so as to guard against the evils arising from the employment of careless or incompetent workmen. Hence, it would seem advisable to insert a stipulation in the general conditions that would give the architect or owner the power to dismiss such workmen.

8. It is well that the contractor should guarantee the work for some stated period, after it is completed and accepted, in order that he may, without additional cost to the owner, make good such defects that may have been overlooked. This will avoid a possible lawsuit where the jury would have to decide the scope of the implied warranty, which exists in all contracts, and how long it held good. Where it is desired to provide this stipulation in the general conditions, it may be stated somewhat as follows: "The contractor is also, at his own cost, to amend and make good any defects, settlements, shrinkage, or other faults in his work, arising from defective or improper materials or workmanship, which may appear within one year after the completion of the building."

9. There is always some expense attached to the carrying out of the rules governing building operations in towns and cities. Outside of the mere expense of securing city permits, etc., there are often the numerous and somewhat changeable wishes of the building inspector to be complied

with. A stipulation, covering the contingency of such expenses, may be inserted in the final contract, though it would be better to place it among the general conditions. The contractor, in bidding on the work, can then take into account the cost that he may incur in complying with such a stipulation.

10. The care of the building during erection should be properly provided for in the general conditions, fixing the responsibility upon the contractor, and stipulating that "he shall provide all necessary guards, rails, and night lights, and be responsible for all property injured upon, or stolen from, the premises."

Where it is desirous to have the building completed by a certain date, it is well to so stipulate in the general conditions, as well as in the contract, for then the builder will not have the excuse that when he bid on the work, he did not know there was to be a time limit. It is much better for the architect, in fixing the time limit, to divide the construction of the building into stages, and to fix successive dates at which each stage shall be completed, instead of stipulating only the date for the completion of the entire job. The advantage of stipulating successive dates for different stages of the work, lies in the fact that the architect is better able, during the progress of the work, to determine whether the builder is likely to finish on time or not. That is, if the builder should fail to have the first or second stages of the work done at the stipulated time, the architect can notify the owner and have the contract rescinded, and it will not be a difficult matter to prove that the builder was negligent. Where, however, only the final date of completion is stipulated, and the architect, judging from the appearances of the work, has reason to believe that the builder will not finish in the stipulated time, may remonstrate with him—the only result being, that he is told by the confident contractor that the work will be completed on the specified time; and should the architect or owner rescind the contract at the early stage of the work, they might be called into court for

damages, and required to prove the incapacity of the builder to finish on time—a thing which might be difficult to do.

11. The general-condition clause should read somewhat as follows:

GENERAL CONDITIONS.

The contractor shall give his personal superintendence to the work, and furnish all materials, transportation, labor, scaffolding, and appliances required for the full performance of the work herein specified, except as may be otherwise definitely mentioned. He shall lay out his work, and be responsible for its correctness; and shall not sublet any part of this work without the written consent of the owner or architect. He shall keep, during working hours, a competent foreman at the works. He shall obtain all the necessary permits, paying the lawful fees charged therefor; shall give the requisite notices to the proper authorities relative to the work in his charge; shall be liable for all accidents to persons, or damage to property, traceable to the negligence of himself or his subordinates, and shall be responsible for any violations of local laws or ordinances. He shall, in fine, duly and adequately protect his work at all time during its progress.

All materials employed in construction are, unless otherwise specified, to be the best of their several kinds, subject to the approval of the architect and owner. All labor is to be performed in the best and most acceptable manner by skilled workmen, and both workmen and workmanship are subject to the architect's approval. All work and materials must conform to the laws and regulations in force in the locality, notwithstanding anything hereinafter specified and provided that may be construed to the contrary. The drawings referred to in this specification are made to a scale of $\frac{1}{4}$ in. = 1 ft., and will be supplemented by detail drawings, furnished as the work progresses.

All these drawings are intended to cooperate with this specification, to form part thereof, and also form part of the contract. Where figures are given, they are to be followed in preference to measurement by scale. The drawings and specifications furnished for this work are instruments of service and the property of the architect, to be returned to him on completion of the work herein set forth.

The contractor shall, while the work progresses, keep the premises in a cleanly condition, free from rubbish and from all undue accumulations of surplus material. He shall, upon the completion of the work, remove all débris and rubbish, repair any damage done to the work, no matter how or by whom caused (except loss or damage by fire), leaving the premises broom clean and in perfect order and repair at the termination of his work. He shall provide all necessary guards, rails, and night lights, and be responsible for all property injured upon, or materials stolen from, the premises.

The work shall be under the supervision of the architect or the architect's representative, who shall, at all times, have access to, and power of inspection over, the works, to accept materials or workmanship in his judgment satisfactory, or reject work and material not in accordance with the drawings and specifications. His decisions as to the interpretation or intent of the drawings and specifications shall be final and binding on all parties concerned.

The owner reserves the right to accept or reject any or all proposals submitted. He shall have the site surveyed and staked, furnishing the necessary lines and levels.

The contractor shall lay out the building in accordance with the drawings and directions, and shall be not only responsible for its due and accurate location on the lot, but liable, besides, for any damages inflicted on the owner or on adjacent property owners, from failure to comply, in this respect, with the drawings and directions.

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12. After the general conditions are disposed of, the specification should be divided up under separate headings according to the number of different trades which are represented in the work to be done.

These headings should be prominent and conspicuous, and, when convenient, should be at the head of a page in order that the specification may be divided, if desirable, to give each contractor or subcontractor the portion that relates to his own particular work.

Under each heading there should be subheadings indicative of the different subdivisions of the work, but each general heading should cover all the operations included in the trade which it sets forth. For instance, these headings being "Masonry," "Carpentry," "Plumbing," "Painting," etc., then, under the general heading "Masonry," should be the subheadings of "Excavation," "Mortar," "Pavements," "Walls," etc.

MASONRY.

EXCAVATIONS.

Clear away all rock, dirt, or rubbish; excavate for the cellar, footings, areas, front wall and steps, cesspools, drains, etc.; complete, also, all other excavations required to carry out the work as specified. Excavate to the full depth, as indicated, making the excavation for the

cellar (12 inches) wider all around than shown on the cellar plan. The foundation walls must extend at least (4 feet) below the finished grade of the lot, so as to be under the frost line.

All earth or rock from the excavation, not required for filling in, or grading, is to be removed from the premises. The grade lines, shown on the drawings, are the lines to which the lot is to be graded, after the completion of the building. The existing grades are not shown on the drawings. Fill in the earth around the cellar walls, piers, and cesspools, along the street wall in front and over the broken stone and gravel filling of the drains, etc. The filling shall, in the case of walls, be done after the mortar is dry, and, in the case of trenches for drains, as soon as the pipe lines are laid and approved by the superintendent. The filling around the walls is, at every foot in height, to be well rammed, the soil banked over the drains, to allow for settling, and the earth sloped away on all sides from the walls of the building.

MORTAR AND CONCRETE.

Lime, cement, sand, and **mortar,** for all mason work throughout, shall be, unless otherwise specifically stated, as follows: (1) No. 1 *Rockland* lime, freshly burned and well slaked. (2) *Brooklyn Bridge brand Rosendale hydraulic* cement. (3) *Saylor's best English Portland* cement. (4) *Vicat Portland* cement. (5) Sand to be clean, sharp, well screened, and free from loam or salt. (6) The mortar to be thoroughly mixed and made in the following proportions: (*a*) *Lime mortar:* one part lime, *three* parts sand. (*b*) *Rosendale cement mortar:* one part cement, *two* parts sand. (*c*) *Portland cement mortar:* one part cement, *three* parts sand.

Concrete shall be composed of one part Rosendale cement, *two* parts sand, and *three* parts clean *broken stone.*

FLOORS, PAVEMENTS, AND COAL CHUTES.

Cellar Bottom.—Level off the earth in the cellar bottom to a depth *six* inches below the finished floor level, tamp it down well at all points, and lay a *Rosendale* cement concrete bottom *five* inches thick; settle it down thoroughly and finish with a (1-inch) top dressing composed of *Portland* cement and sand in equal parts, to be floated to a smooth surface and so graded to the *outside cellar door* that the cellar may be drained. Form in the cellar bottom a channel along the foundation wall, through which to run the house drain, forming along the edge of this channel a lip (1 inch) high, to throw the water off in case the cellar is washed out. This channel is to be graded to meet the grade of the house drain, and shall then be finished with Portland cement.

The area bottoms shall be of concrete, the bottom layer of *Rosendale* cement concrete, *three* inches thick, well rammed and leveled up. Finish with (1 inch) of *Portland* cement, hereinbefore described; trowel down to a smooth surface graded to the cast-iron strainer, which shall be furnished and set by the plumber. Other concrete work is specifically stated under the titles "Cesspool," "Trap Pit," etc.

Coal Slide.—Build in a (12-inch) vitrified tile pipe, laid in *Rosendale* cement mortar, firmly bedding it in the wall. This pipe must be given a pitch of not less than (30°); it must be brought up to grade and finished with a (3-inch) *bluestone* flag. Cut an opening in the stone, in which set a cast-iron frame and manhole cover, the frame to be set in cement and well secured to the stone. The cover is to be provided with a suitable wrought-iron chain extending to the inside of the cellar wall, the last link of the chain fitting over a staple firmly attached to the wall.

DRAINS AND CESSPOOLS.

Subsoil Drains.—Lay a *three-inch* porous agricultural tile drain along the footings all around the foundation walls of the building; the crown of the grade shall be at the point (*A*) indicated on the drainage plan; the bottom of the tile drain at this point to be level with the top of the footing stones. Lay the pipe with an even grade to the point (*B*); increase the pipe at this junction to *four* inches, and continue the line with the same grade to the *dry cesspool* in the rear of the premises. The drain must not, at any point around the building, be lower than the lower edge of the footing course. Cover the drain around the building with a good layer of new straw; fill up the trench to within a *foot* of the grade with broken stone, and finish to grade with top soil. Lay *six* lines (in all 400 feet) of *three-inch* agricultural tile, starting at a depth of *one* foot below the surface, and laying at a suitable uniform grade to the main outlet. The main line shall start with a *four-inch* pipe, to be increased at the point indicated to a *six-inch* pipe. From this point, continue the line *six* inches in diameter to the *dry cesspool*. The joints for all agricultural pipe should be open (¼ inch), and, where straw is not used, covered with strips of paper to keep out the earth. Bed the pipe firmly, tamping the ground well on each side, to keep the drain in alinement.

Leader Drains.—Lay the drains of vitrified earthen pipe for the discharge of rain water as follows: From the *two* leaders at the rear, lay lines of *four-inch* pipe as shown, increasing them to *five-inch* pipe, where the front leaders enter; continue the lines to the junction indicated, and from there to the front of the property line lay a *six-inch* pipe. The drain from the front of the property line to the street gutter shall be of *six-inch extra heavy cast-iron* pipe; the drain to

finish at the curb, with a *galvanized cast-iron strainer*, well secured to the face of the curbstone.

All branches and connections on this line of drains shall be made with Y branches, and (⅛) bends. The base of each leader, to a height of (3 feet) above the grade, shall be of *extra heavy cast-iron* pipe; the drain pipes are to be firmly bedded in place, and laid with a uniform grade of at least (¼ inch) per foot throughout. All joints shall be made tight and clean, cemented together with hydraulic *Portland* cement mortar, mixed in the proportion of one part cement to *two* parts sand. As each joint is made, any mortar entering the pipe must be thoroughly cleaned out with the hand, or by means of a semicircular hoe-shaped scraper, fitting the inside diameter of the pipe.

Cesspool.—Lay footings and build the walls of the cesspool of good sound quarry stone, the walls to be (20 inches) thick, laid in *Rosendale* cement mortar, carried up and leveled at a point *six* feet above the top of the footings. Lay a *Rosendale* cement concrete bottom (3 inches) thick, tamping it down well, and finishing with a (1-inch) top dressing of *Portland* cement and sand, similar to the cellar-bottom finish. Plaster the walls of the cesspool inside and outside with *Portland* cement mortar. Provide an opening in masonry for overflow, (3 inches) below the inlet; lay a *five-inch* vitrified earthen-pipe line with a uniform grade of (¼ inch) per foot to the blind cesspool, the inlet opening to have an elbow turned down into the cesspool. This overflow pipe is to be laid in a manner similar to drains for leader pipes. The brick dome and finish of the cesspool are specified under the head of brickwork.

Dry Cesspools.—Construct a dry cesspool, of the dimensions shown on plans, *six* feet deep in the clear, the walls to be of sound stone (18 inches) thick, laid up dry. Fill in with small broken stone to the top, and pile the stone in the form of a pyramid, till the top is within *one* foot of the finished grade. Excavate a pit 2 feet square and 2 feet deep under the cellar-entrance area and fill with broken stone.

WALLS.

13. It will be seen that the subheadings do not always follow in the order in which the work is conducted in the building. This change of arrangement is necessary in order that the contractor may be aided as far as possible in making his estimates; therefore, immediately after the description of the kinds and qualities of mortars and cements required, the description of the work follows, which consists largely of concrete or cement.

The same will be observed under the following subheadings, commencing with "Walls." All the work pertaining to the walls is first described, whether the material is brick or stone; then follow the conditions to be observed in the material and workmanship required of the stone mason and the bricklayer.

Footings.—Put down under all walls, chimneys, piers, exterior steps, etc., where solid rock does not occur, footings of large, flat, sound stones, *eight* inches thick, each stone being of the full width indicated, the footing stones under the piers to be in one piece. Flush up to a level bed all around with spalls and *Rosendale* cement mortar.

Foundation Walls.—Build up foundation walls of large, sound quarry stone, well tied and bonded with through stones. The walls up to grade are to be substantial rubble, constructed with good, sound, flat, quarried stone, the through stones to be inserted at intervals of *four* feet in length and *two* feet in height, all walls to be laid to a line on both sides, the joints and interstices in the walls to be well filled with spalls and cement mortar, and all joints weather-pointed inside and out with *Portland* cement mortar. Form pipe chases and all openings in the walls as required by the cellar plan.

Damp Course.—On a line averaging six inches above grade, lay a damp course as follows: Level the wall as much as the stone courses permit, and cover with a good coat of liquid *Trinidad* asphalt, applied hot, covering it with heavy-weight *tarred* paper and finishing with another coat of asphalt on top. Plaster the walls below grade, from footings to damp course, with *Portland* cement mortar and coat with asphalt.

Areas.—Build up the walls of area and cellar steps, and areas for cellar windows, as indicated, with stone (16 inches) thick; cope with *rubbed bluestone* (5 inches) thick, projecting ($\frac{3}{4}$ inch) over the face of the wall; the steps to cellar area to be of *rubbed bluestone* (7 inches) thick, in one piece, with the ends and backs housed into the wall *two* inches. Build foundations for veranda piers, porch piers, and piers for the porte cochère up to grade with sound quarry stone, laid in *Rosendale* cement mortar.

FRONT OR STREET WALL.

Lay the footings (4 feet) below grade, and build the foundation of the wall along the front of property (24 inches) thick, of large, sound quarry stone with flat beds. Level up the footing course with spalls, and build the wall up to grade, laying it in *Rosendale cement* mortar.

Back up the ashlar facing above the street grade to the coping line, with rubblework laid in *Rosendale cement* mortar, taking care to allow none of this mortar to come in contact with the ashlar. Point the foundation, below the grade on both sides, and the backing with *Portland cement* mortar.

Ashlar Facing.—Face the foundation wall above grade with *blue limestone random* ashlar, (6 inches) and (10 inches) in thickness, no piece of ashlar to measure less than (4 in. × 6 in.) on the face, and no joints to be greater than ($\frac{3}{16}$ inch) in width. Make all joints level, true to a line and broken, no vertical joint to be more than (12 inches) in height. The sides or builds of ashlar must be neatly jointed, and the stones set, without exception, on their natural bed.

Plaster all ashlar on the back, and bed it in mortar composed of *Vicat* cement *one* part, and sand *two* parts. Rake out all joints to a depth of ($\frac{3}{4}$ inch); clean the face of the stonework with a stiff steel brush, and point the joints with *Vicat cement* mortar. Use a steel jointing tool for the final pointing of this work.

Bond every stone with the *brick* backing, and tie all stones over (8 inches) in height with *galvanized wrought-iron* anchors let *two* inches into the stone and extending at least (4 inches) into the backing. All cut stonework to be executed in strict accordance with the drawings, and as required by the specifications—comprising jamb stones, quoins, lintels, sills, and other dimensioned material, all to be *clean cut* and worked to the form indicated on the detail drawing. Build the piers under the veranda, porch, and porte cochère of *coursed limestone* in rock-faced ashlar, of the dimensions shown on the drawings, and lay with a level bed in *Vicat cement* mortar. Cut a 1-inch *chisel draft* on the corners of the porte-cochère and porch piers, besides *clean-cutting* the cheeks of all piers for the fitting of lattice frames or other woodwork.

Cut a (1-inch) margin all around the top of the porte-cochère piers, but cut the margin on the outside faces only of the veranda and porch piers. Cut, also, a (1-inch) margin all around the top of the foundation wall, and finish the top of the wall to a true level.

Facing.—Face the front or street wall with *rock-faced limestone coursed* ashlar as shown, the wall to be (18 inches) thick above grade, the height and other dimensions to be taken from the drawings. Lay a good coat of *Vicat* cement on top of the foundation wall, and with this cement, plaster the back of all ashlar facing. The method of laying, the thickness of facing, and the width of joints are to be the same as those specified for the foundation walls of the building.

Wall Coping.—Cope the walls with a 5-inch *fine-axed bluestone*, projecting ($\frac{3}{4}$ inch) over the wall on both sides, and pitched on top.

The cover pieces of the coping shall be (7 inches) thick, with lugs cut on, to form a cover joint as shown.

Gate Pillars and Wheel Guards.—Build up the gate and end piers with dimension blocks of stone as indicated; drill all holes for gate hinges, etc. at the points directed. Build in wheel curbs at the carriage entrance as shown, each to be in one piece, *clean-cut* finished.

The **caps** of **stone pillars** shall be cut in one piece with ball on top and *fine-axed.* All this work shall be well anchored and bonded together, the joints raked out at completion and pointed with strong *Vicat* cement, a steel jointer being used to finish the pointing.

The steps are to be (7 inches) thick, of *rubbed bluestone* in one piece, having (2 inches) cover at ends and back; the cheek pieces are to be (7 inches) thick and (14 inches) long; the topmost step (16 inches) wide. Cope with (5 inches) *fine-axed bluestone*, and finish as indicated.

Cut-Stone Work.—All cut stone used on the premises must be sound, uniform in color, free from seams, sand holes, and other imperfections; all rock-faced work to be newly cut, showing a clean face, free from tool marks. All beds are to be squarely cut, all side cuts vertical through the full depth of the stone, and all corners and edges cut clean and sharp.

Samples of the stone in *six-inch* cubes, having the sides worked to show the cutting and finishing specified, must be submitted to the architect for approval. These samples should be taken from different parts of the quarry, to represent a fair average of the stone in respect to quality and to color. The samples having been approved, the stonework furnished must be, in every respect, equal to these samples.

Bluestone.—All *bluestone* in copings, steps, etc. is to be of clear, sound stock, uniform in color where exposed to view, and free from flaw or imperfection. Set the *bluestone* as here described on its natural bed, in *Portland* cement mortar, except where it may come in contact with ashlar facing or other *limestone* in the foundation walls, when *Vicat cement* shall be used.

Provide and set *fine-axed* templets under the girder ends in the wall (12 in. × 12 in. × 5 in.). All piers in the cellar shall have (5-inch) *fine-axed bluestone* caps and *one fine-axed* bond in each, the same size as the piers. Chimney caps, also, are to be *fine-axed*, in one piece (5 inches) thick, and have a projection of *one* inch over the top course of brick. Make the cover over the cold-air duct (3 inches) thick, in lengths at least (30 inches), with a (6-inch) bearing on the wall at each side of the duct. Make the trap-pit cover (3 inches) thick, and (10 inches) larger each way than the size given for the trap pit itself.

Give the lintel over the kitchen fireplace an *eight-inch* bearing on

the jambs, and make it (8 inches) thick, its face and soffit to be *rubbed*. The covers over the cesspools are specified under the head of "Brickwork." Place a step flag *four* inches thick at the foot of veranda and porch steps; set in sand well rammed, bedding the flags evenly, leaving no hollow spaces under them, and giving them a pitch of ($\frac{3}{8}$ inch) to the foot.

Secure and bind together all coping and horizontal stone courses with *brass joggles*, countersunk and set in molten lead.

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14. The preceding paragraphs describe the walls and facing of the building, but do not distinctly set forth the special conditions to be observed by the bricklayer. Therefore, under a subheading should be introduced a description of all the brickwork not included in the previous paragraphs under the subheading of "Walls."

BRICKWORK.

All brick shall be *wet* when laid in dry, warm weather, and *dry* when laid in *damp* or *wet* weather. Use sound, hard, well burned brick throughout; the work to be well bonded, tied in every *sixth* course, and worked in *regular* bond with full-flushed joints, leaving no interstices. All walls, piers, etc. are to be plumb and built to an exact line, the walls to have all necessary openings, pipe chases, etc., as required by the drawings. Back up the ashlar facing from the top of the rubble stonework to the sills with brick, backing up each course of stone as it is set. Begin the brickwork on the stone foundation with a rowlock course, and carry the brick up between the floor joists to within (1 inch) of the under side of the flooring. Build window and door jambs plumb and true, and set stone templets under the girder ends in the wall, leaving ($\frac{1}{2}$ inch) space at each side of the girder.

Care must be taken to allow no other than *Vicat cement* mortar to come in contact with the ashlar facing.

Build the partition walls of the cellar to the dimensions stated, and turn *three-course rowlock* arches over the openings in these walls; carry the brick to within (1 inch) of the flooring. Build up the walls of the dumb-waiter shaft in the cellar, of brick, (8 inches) thick, bonding it in every *sixth* course. Build the opening in this shaft, turning a *flat* arch over it, the opening to be (2 ft. $\times$ 4 ft.), with the sill (18 inches) above the finished cellar bottom.

Construct the piers in the cellar to the dimensions given; these piers shall have a (5-inch) bond stone built in half way up, and be capped with a (5-inch) stone.

Furnace Pits, Etc.—Construct the cold-air duct, furnace pit, and trap pit with (8-inch) brick walls, thus forming the sides; the size of the furnace pit is to be obtained from the heating contractor.

The **cold-air duct** is to be (15 in. × 30 in.), inside measurement, and run from the wall of the building to the furnace pit; the top is to be covered with (3-inch) flagstones laid with close-fitting joints (1 inch) below the cellar bottom, and these flagstones covered over and finished flush with the cellar bottom in *Portland* cement top dressing. Cover the trap pit with a (3-inch) *bluestone* flag, laid flush with the floor. Lay the bottoms with cement concrete, the same as the cellar bottom.

Brick-Set Furnace.—The furnace shall be enclosed with brick walls of the dimensions indicated, the walls to be (10 inches) thick, laid up in *lime*, *Rosendale cement* mortar. These walls shall be built hollow, with a (2-inch) space between, and tied together with *galvanized-iron* anchors, set (24 inches) apart, in every *sixth* course. Set all iron door frames and doors which the heating contractor shall furnish. Form the flues and all openings required. Furnish and set (2 in. × 1½ in. × ¼ in.) T iron, spaced (8½ inches) on centers. Lay on these bars *two* courses of brick, laying the courses flat and the upper course parallel with the T bars. Cover all over with a (2-inch) coat of *Rosendale* cement mortar. While the walls are being laid, plaster the brickwork on the inside with a good coat of mortar, composed of *lime*, *sand*, and *plaster of Paris*, in equal proportions.

Cesspool Dome.—Start the brick dome of the cesspool so that the first course shall measure (18 inches) in width on top of the stone wall, with the next *five* courses racked and laid so that the *seventh* course will bring the brickwork to (8 inches) in thickness. The first course on the inside shall be laid in rowlock, and the dome carried up perfectly round, keeping the inside smooth. Draw in to a manhole (24 inches) in diameter, which shall have a brick ring (8 inches) wide built up *two* courses above the dome. Cover the manhole with a (4-inch) *bluestone* flag, to have at least (8 inches) bearing all around.

Chimneys.—Construct chimneys as required by the drawings, carrying these up perfectly true and plumb, so that in no case shall there be less than (8 inches) of brickwork between the smoke flues and any timber or woodwork. The chimneys must be built entirely free and independent of the framing. Form ash-pits as required by drawings, providing and setting for each a cast-iron frame (12 in. × 14 in.) with lugs to build into the brickwork, and a cast-iron door properly hung and fastened. All flues shall be run direct and to the top of the chimney, independently of one another. They shall have between them four-inch partitions, and shall, unless otherwise specified, be lined with (8 inches) square fireclay lining, which shall run the entire altitude to the chimney cap, and there be cemented tight. The flue

lining shall be well bedded in the brickwork and built in, while the chimneys are in course of construction.

Run the furnace flue down to within *two* feet of the cellar floor. Provide and set here a cast-iron door (12 in. × 14 in.), with a cast-iron frame identical with that used for the ash-pit. All other flues not terminating in a fireplace shall be carried down to the cellar and provided with (8 in. × 10 in.) cast-iron clean-out doors in suitable cast-iron frames. The furnace flue shall be lined with (8 in. × 12 in.) fireclay pipe, and the ash flues with (4 in. × 8 in.) fireclay pipe.

Top out the chimneys above the roof, to conform to the detail drawings, carrying the rough brickwork up to the flashing line. The *tinner* shall furnish, and the mason set, painted apron flashings for all chimneys; and these shall be so set in the joints that not less than (6 inches) shall be at any point visible. The flashings shall be stepped on the raking lines of the roof, and the joints on the chimneys well cemented with slater's cement.

The chimneys, from the flashing line to the cap, shall be faced with *red hydraulic pressed brick*, laid up in *lime* and *Rosendale cement* mortar, and pointed with *red* mortar as before specified. Set and bed evenly the chimney caps in *Portland* cement mortar.

Furnish and set in place for the tall chimneys a wrought-iron rod, (1 inch) in diameter, to run through the chimneys. At the rear face of the chimney the rod shall have a shoulder welded on, against which a washer shall be put, before the rod is placed in position. Thread the outside end of the rod for a nut. Flatten the rod out to a flange (2 inches) wide and (10 inches) long, bent to conform to the angle of the roof, and having three spike holes. Spike the rod securely to the roof, flashing around it before the shingles are laid with (6-pound) sheet lead. Wash down all chimneys and the kitchen fireplace as well, when completed, with dilute acid; apply, also, a good coat of raw linseed oil, taking care that no oil or acid comes in contact with or damages the stonework or any other work.

Fireplaces.—Form the rough fireplaces as shown, with *flat* arches on *wrought-iron bars* ($\frac{1}{2}$ in. × 2 in.), turned up at the ends. Construct proper ledges in the throats of the fireplaces, and insert adjustable iron dampers. Face the fireplace in the *reception hall* with *red hydraulic pressed brick*, *standard* size, and the fireplace in the *dining room* and *library* with *buff mottled hydraulic pressed brick* ($1\frac{1}{2}$ in. × 12 in.). The face brick in the fireplaces shall be laid with ($\frac{1}{8}$-inch) joints, in *lime* and *Rosendale cement* mortar, colored with mineral mortar stains to *match* the brick. The reveals of the fireplace openings shall show (4 inches) of brick.

Build the kitchen fireplace as indicated on the drawings, and face the breast, jambs, and throat with *red hydraulic pressed brick*, laid up with ($\frac{3}{16}$-inch) joints in *lime* and *Rosendale cement* mortar, *colored*

to match. Set a *bluestone* lintel, as already described. Keep the face brick of the fireplace full (2 inches) beyond the body of the chimney, so that, when put on, the furring and plastering shall line up with the finished brickwork.

Detail drawings will be furnished for all fireplaces. The color of tile in the facings and hearths shall be selected and determined by the *owner.* All *tile* in the hearths and facings, *cast-iron linings*, *metal frames*, *grates*, etc., shall be furnished and set by the *mantel contractor*, *under separate contract.* The mason shall, however, supply all necessary brick, cement, sand, etc., required for the setting of *tile* in fireplaces and hearths.

Registers and Thimbles.—The *heating* contractor shall provide, and the mason shall set, a vent register in the kitchen chimney breast, at the point indicated. Provide and set a (9-inch) *cast-iron* thimble in the chimney for the furnace flue, the top of this thimble to be (6 inches) below the floor joists. Set, also (5½-inch) *galvanized sheet-iron* stove-pipe thimbles—one in the *laundry*, and one in *each attic bedroom.*

Trimmer Arches and Hearths.—Turn trimmer arches for all hearths, and level up all but that in the kitchen to the top of the floor joists with Portland cement for tiling. Make the bed for kitchen hearths (2¾ inches) below the surface of the finished floor. Furnish and set in the kitchen a *rubbed bluestone* hearth (3 inches) thick, well bedded in *Portland* cement, to show (½ inch) above the finished floor.

Preparation for Tiling.—The carpenter shall prepare for, and the mason shall set, a course of brick *on edge* in *Portland* cement mortar between the joists in the *bathrooms*, filling in the joints with mortar, leveling up the work to within *one* inch of the finished *hall* floor. The *tile* shall be furnished and set by the *mantel contractor*, and the *marble slabs* duly put in place by the *plumber.*

The carpenter shall, while the foundation walls are in course of construction, provide and set the window and door frames, or any other necessary woodwork. The frames shall be set perfectly plumb and must be well bedded. The check of the quoin stones and lintels in the mason's openings shall be plastered with a (¼-inch) coat of *Vicat cement* mortar, securing a water-tight joint between the frames and mason work.

Whitewashing.—Cover all brick and stone walls in the cellar, including the inside walls of the dumb-waiter shaft from floor to ceiling, with two good coats of whitewash, composed as follows: *ten* parts of freshly slaked *lime* to one part of *hydraulic Portland* cement. Note, however, that the walls are to be pointed up smoothly by the mason, then allowed to dry, and subsequently brushed down before applying the whitewash.

INSIDE MASON WORK.

15. Up to this point the specifications have described all the mason work required on the building, so far as its erection is concerned, exclusive of inside finish. There should now follow a detailed description of all the inside work called for in the province of the mason, tending towards the finish of the building and the completion of his contract.

LATHING AND PLASTERING.

Lathing.—All walls, ceilings, partitions, and work furred off throughout the building, including the cellar ceiling and dumb-waiter shaft, are to be lathed with sound dry *spruce* laths, unless otherwise specified. These laths shall be put on ($\frac{1}{4}$ inch) apart, with four nailings to each lath, the joints to be broken at every *tenth* lath. Back-lath all walls, nailing the lath to furring strips where the wood wainscot occurs. No laths shall be put on vertically, nor run through behind studs, from one room to another, the plasterer seeing to it that all angles are solidly formed and that the furring is securely nailed before the laths are put on. The *bathroom* walls, back of the *tile* wainscot, shall be covered with *expanded metal lath*, provided and put up by the plasterer. All pockets in partitions, through which heater pipes are run, shall be covered with *expanded metal lath*, provided and put up by the *heating* contractor.

Plastering.—Plaster all walls, ceilings, and partitions over the lathing just described, unless otherwise specified, with *two* coats of mortar, a *scratch* and a *brown* coat, composed of pure, well slaked lime, clean, sharp sand, and best cattle or goat hair, the hair to be well beaten and soaked in water.

Body of the Work.—The scratch-coat mortar shall be mixed in the proportion of *one* barrel of lime, *three* barrels of sand, and *one-half* bushel of hair. The brown-coat mortar shall be mixed in the proportion of *one* barrel of lime, *five* barrels of sand, and *one-quarter* bushel of hair—all to be thoroughly mixed and stacked in the rough, until ready for use. The brown mortar should stand from *one* to *two* weeks, and the scratch mortar *three* days, before being used.

Apply the scratch coat with sufficient force to secure strong clinches, and scratch well with a wooden comb. The scratch coat should not be allowed to dry hard before applying the brown coat. Apply the brown coat, and float to a smooth, even surface, flush with grounds. All ceilings shall be made perfectly level, all walls plumb and true, and all angles sharp. Carry the scratch and brown mortar back of all bases, and back-plaster behind the wainscoting, etc., down to the floor.

King's Windsor Cement Finish.—The plaster frieze in the *first-story hall* between the dado and the wood cornice, as well as the ceiling panels and the side walls of the *vestibule*, shall be plastered *two* coats with (King's Windsor cement) mortar, mixed in the proportions herein specified for outside plastering. Apply a good scratch coat over lath, and comb, and allow the mortar to set well, but not to thoroughly dry. Apply a *second*, or *finishing*, coat of the same mortar, and trowel it down flush with grounds; float off to a perfectly true, even surface, making all angles sharp and the corners plumb and true. These wall surfaces shall *not* be white finished, but shall be *tinted* by the painter.

The walls of the dumb-waiter shaft, down to the under side of the first-story joists, shall be finished with *two* coats of (King's Windsor cement) mortar.

Plaster over metal lath in the bathroom, with a scratch coat of (King's Windsor cement) mortar, and scratch to a rough surface. Finish with a good coat of *Portland cement* mortar troweled down, and left ready for the tile setter.

Finish of Walls.—Finish all plastered surfaces over the brown coat, except in *first-story hall* and *vestibule* and behind wainscoting, with a white, hard-finishing coat, composed of lime putty, fine washed sea sand, and plaster of Paris, carefully applied, and troweled down to a perfectly smooth-polished surface, free from trowel or brush marks, or blemishes. The lime used in the finishing mortar must be well slaked, strained through a fine sieve, and allowed to stand for a *week* in a covered trough or in barrels, to insure perfect slaking.

Centers.—Furnish and set plaster centerpieces, not to exceed ($2.00) net, each, in all rooms except the *entrance hall*, where drop lights are indicated on the plans. The patterns shall be selected by the *owner*.

Cornices, Etc.—Run a plaster cove on furring—set by the carpenter in the ceiling angles of the *parlor*, *library*, and *vestibule*—with an (8-inch) radius, the cove to finish with a molded member on the wall only. Run, also, a similar cove of (12 inches) radius with wall mold in *dining room;* run, besides, in the *bathrooms*, the *second-story hall*, the *principal bedrooms*, and *dressing rooms*, a cove of (6 inches) radius without moldings. Run a neat plaster *ogee* cap molding (2½ inches) wide around the walls of the *principal bathroom* over the wainscot tiling.

Arches, Brackets, Etc.—The carpenter shall form the furring required, and the mason shall plaster all arches as indicated. He shall, also, provide and set molded plaster brackets as required by the detail drawings. Where, in any part of the building, the finished

plaster surface meets some other material on the same plane with itself, the place of meeting between the plaster and this other material shall be marked by a ruled line joint.

Plastering on the Outside.—The carpenter shall set ($\frac{5}{8}$-inch) grounds over sheathing lath, and the mason shall cover the lath over with a good coat of (King's Windsor *neat* cement), mixed in the proportion of one part cement to *two* parts of sharp sand—these to be thoroughly mixed in a dry state, using no other ingredients but just enough water to temper the mixture for easy working. Apply this mortar to the *exterior panels* and *open-timber* surfaces, using sufficient force to secure good clinches; trowel down evenly, and scratch with a wooden comb. Allow this scratch coat to settle and become almost dry before applying the finishing coat. Apply, then, the finishing coat of *Portland* cement, "rough cast," in the proportion of *one* part cement, *one* part sharp sand, and *one* part fine gravel—*the mortar to be colored with mineral mortar stains of an approved tint.* Bring the finishing coat up with the grounds, and float off to an even surface.

Patching.—Do all the required patching of the plaster work after the other craftsmen have finished their work; repair all damaged plaster and cracks, leaving the work in a first-class condition in all respects and without room for exception.

CARPENTER WORK.

16. Under the general heading of "Carpentry" should be included all the work on the building pertaining to the woodworking trades. If the carpenter is to include in his contract all the necessary cutting of beams, floors, and other parts of the woodwork, to enable the other contractors to run their pipes, wires, etc., this should be clearly stated in the beginning.

As under the head of "Masonry," it is usual to include in the first part of the specification of carpenter work all the descriptions of the quality or grade of material to be used throughout the job, and then to describe in detail the requirements of the general rough framing and outside work.

The carpenter shall do all the cutting of timber and such other woodwork as may be required by the other crafts for the due execution of their work.

Framing.—The sills shall be halved at the corners, bedded in *Vicat cement* mortar, and set perfectly level. The corner posts shall be set plumb, to a line, and well braced while the other framing is in course of erection. The girths and ties shall be mortised and tenoned into the posts and pinned with *oak* pins. The floor joists and other important timbers shall be so framed that it may not be necessary to cut them for pipes or chimneys. All framing must be kept at least (2 inches) clear of the chimneys. The floor joists shall, in every case, run to within ($\frac{1}{2}$ inch) of the sheathing boards.

All headers and trimmers around stair wells and chimneys shall be of joists, doubled and spiked together, or shall be in one piece, 4 inches thick, hung in *wrought-iron* stirrups ($\frac{1}{2}$ in. $\times$ 2 in.), let in flush with the top of joists. In framing the roof around chimneys, the trimmer rafters and headers shall be doubled and securely spiked together. All joists shall be placed with their crowning edge upwards, and have a bearing of at least (4 inches) on the sills and be well spiked thereto. The studs in the exterior walls shall rest on the sill, be securely spiked thereto, and to the floor joists as well.

Trussed Partitions.—Truss all carrying partitions not resting directly on the sills, or on a wall or girder, with (4 in. $\times$ 8 in.) *spruce*, well framed together and transmitting the weight to posts (4 in. $\times$ 6 in.), resting on the sills or girder, or, if in the second story, on a supported partition below. Truss over all openings (4 feet) or more in width.

Partitions.—Build the partitions as shown on the plans, setting them straight and plumb. The partitions over walls and girders shall run down to these, instead of resting on top of the joists. All other partitions shall have sills, as hereinbefore specified. Make the corners and angles solid by blocking and spiking two studs together. The pockets of sliding-door partitions shall be sheathed with ($\frac{5}{8}$ in. $\times$ 3 in.) tongued-and-grooved *white pine, painted on both sides* before being put on; form guides for door-hanger track, and set these perfectly level and to a line. Provide all openings in the cellar wall with rough wood lintels not less than (4 inches) thick. These lintels shall, at their ends, have, at the least, a (4-inch) bearing in the walls. Provide all templets or forms required for brick arches.

Timber.—All timber, unless otherwise specified, shall be of *spruce*, well seasoned, sound, free from dry rot or other defects and imperfections. The principal timbers shall be of the following dimensions:

(1) **Girders** (8 in. $\times$ 10 in.), *Georgia pine.* (2) **Sills** (3 in. $\times$ 8 in.), laid flat. (3) **Posts** (4 in. $\times$ 6 in.), having a continuous (2 in. $\times$ 4 in.) scantling spiked on one side from the sill to the plate, placed at all angles and corners of the buildings. (4) **First** and **second story**

joists (3 in. × 10 in.), spaced (16 inches) on centers. (5) **Attic floor joists** (3 in. × 8 in.), spaced (16 inches) on centers. (6) **Headers** and **trimmers** (4 inches) × the depth of joists, or joists doubled. (7) **Collar beams** (1¼ in. × 10 in.), well nailed on every *second* pair of rafters. (8) **Plates** and **ties** (4 in. × 6 in.). (9) **Girths** (4 in. × 6 in.). (10) **Ledger boards** (1 in. × 6 in.), notched (1 inch) into studs and posts, and well spiked at every bearing. (11) **Studs** (2 in. × 4 in.), *hemlock*, spaced (16 inches) on centers throughout. The door and window openings, including door openings in partitions, shall have *two* (2 in. × 4 in.) studs from the floor to the head; the heads to be formed in like manner. (12) **Partition sills** and **plates** (2 in. × 4 in.), *doubled and spiked.* (13) **Rafters** (2 in. × 8 in.), spaced (16 inches) on centers. (14) **Hip rafters** and **ridges** (2 in. × 10 in.). (15) **Valley rafters** (3 in. × 10 in.).

The veranda, porte-cochère, and porch timbers shall be as follows:

(1) **Sills** and **cross-sills** (4 in. × 8 in.). (2) **Floor joists** (3 in. × 8 in.), cut in between and set (20 inches) on centers. (3) **Ceiling beams** and **rafters** (2 in. × 6 in.), set (20 inches) on centers. (4) **Hips** and **valleys** (3 in. × 8 in.). (5) **Plates,** *two* pieces (2 in. × 10 in.) *spiked* together. Provide and set, likewise, all other timber required to fully complete the work.

Bridging.—Bridge floor joists on every floor with *one double* row of (1¼ in. × 3 in.) *cross-bridging* to each span (10 feet) or over, and *two double* rows to all spans (15 feet) or over; all to be cut in and nailed at each end with *two* 10d. nails.

All outside walls and inside partitions shall be bridged *once* in their height with pieces (2 in. × 4 in.), cut in *diagonally* and nailed at each end with *two* 10d. nails.

Put in (2 in. × 4 in.) pieces horizontally between the studs in the *bathroom* partition, (12 inches) apart, to a height of (4 feet) above the floor to afford extra support for the metal lath.

Grounds, Furring, Etc.—Cross-fur the ceilings of veranda, porte cochère, and porch, with (1 in. × 2 in.) *spruce* furring strips placed (16 inches) on centers.

Fur all chimney breasts where pressed brick or tile facing does not occur, with (1 in. × 2 in.) *spruce*, well nailed to the chimneys and spaced (16 inches) on centers. Nail (1 in. × 2 in.) furring strips on the sides of studs where the wainscot occurs, for back plastering.

The side walls in the *hall* and *vestibule* shall be furred *vertically* on studs with (1 in. × 2 in.) *spruce* strips for plastering. Set furring strips (2 inches) wide, *one* at the floor, and *one* half way up for all wainscoting, except that in the *bathroom.*

For the molded cap over the dado, and for the wainscot cap in the *vestibule*, set a (2 in. × 4 in.) furring strip, to be rabbeted for dado and

plaster; also set furring for wood frieze, cornice, and plaster panels on the ceilings. Put up (2 in. × 4 in.) furring for false beams, well framed together, set to a line and hung from joists above.

Prepare the *principal bathroom* for floor *tiling*, and the *servants' bathroom* for *marble slabs*, by laying ($\frac{7}{8}$ in. × 4½ in.) tongued-and-grooved boards on (1 in. × 2 in.) cleats, nailed to the floor joists. The boards shall be laid tightly and well nailed, to finish (5 inches) below the level of the top of joists in the *hall* or adjoining rooms.

Rough Flooring.—Lay an under floor throughout the first and second stories of ($\frac{7}{8}$ in. × 6 in.) tongued-and-grooved *spruce*, surfaced on one side, laid *diagonally* on the joists, and *top* nailed at every bearing with *two* 8d. nails. Run this flooring closely around all studs and up to the outside sheathing boards, breaking the joints on the joists only; never between. Provide and set suitable nailing pieces between the joists and studs to take the ends of the flooring. Lay the attic floor with ($\frac{7}{8}$ in. × 6 in.) *spruce*, of the same stock as that used for the under flooring in the other stories, selecting the best on the ground for the purpose. This floor must be well driven together, *blind* nailed to every bearing, fitted closely around all studs, and run up to the sheathing.

Sheathing.—Cover the entire frame of the building in the first story with ($\frac{7}{8}$ in. × 6 in.) tongued-and-grooved *North Carolina pine*, surfaced on one face to a uniform thickness, put on *diagonally*, making joints only on studs, and breaking these joints; secure the covering with *three* 8d. nails to every bearing.

Sheathing Lath.—Cover the frame from the belt line at the second-story floor to cornice and into gables, as well as the faces of dormer windows, with ($\frac{7}{8}$ inch) *Byrkit-Hall pine* sheathing lath, having edges tongued and grooved. Put on horizontally and secure with 8d. nails.

Sheathing Paper.—Cover the frame over the sheathing boards up to the second-story level, with *heavy-weight resin-sized felt paper*, laid with a (3-inch) lap and tucked under sheathing lath, against studs and under all corner boards, casings, etc.

Roofs.—Cover all the roofs and dormers with (1¼ in. × 3 in.) *spruce* shingle lath, laid on roofs with about (2 inches) space and on cheeks of dormers with about (1½ inches) space between. The foot of all roofs along the gutter line, all valleys, hips, and ridges shall have a (1¼ in. × 10 in.) board nailed on with *three* 10d. nails to each bearing.

Shingles.—Cover the roof with XXXX *sawed cedar* shingles (18 inches long and none less than 3 inches in width), laid on (5 inches) to the weather and secured with at least *two* 4d. cut nails to each shingle. Cut the shingles to a line along valleys and hips, and cover all hips and ridges with a capping course known as *Boston hips*.

The shingles on the face and cheeks of dormers shall be of uniform width, and laid (4½ inches) to the weather. The valleys shall be (4 inches) wide. All shingles shall be *dipped* by the *painter* and allowed to dry before being put on.

The carpenter shall see to it that all flashings of valleys, hips, etc. have been, as specified under *tinner's work*, properly laid before placing any shingles in position.

OUTSIDE FINISH.

17. The work to be done on the outside of the building should be grouped under one general subheading, in order that it may be easily picked out in looking over the specifications.

All outside finishing, lumber, moldings, etc. shall be, unless otherwise specified, of clear *white pine*, which shall be worked to conform to scale and detail drawings, and as soon as practicable after having been placed in position, primed by the painter.

Cornices.—Form the main cornices with (1⅛-inch) facia, (1 in. ×4 in.) crown molding, (1⅛-inch) plancier, etc. to conform to details. Support the cornices with (1¼-inch) rough *spruce* brackets, spaced (2 feet 8 inches) on centers and securely nailed to the frame. Form the gutters with (1⅛-inch) boards, laid with the proper grade to the points indicated for leaders.

Barge Boards.—Finish the front of main gables with (2 in. × 10 in.) plank, dressed, chamfered, and finished as indicated.

Open Timber Work.—The open timber staves shall be (⅞ inch thick, and from 4 inches to 6 inches wide), *clear white pine;* all joints to butt; end pieces to be rabbeted (½ inch) under the points where they are jointed to another piece. The method of jointing and other details of open timber work are clearly indicated on the detail drawings. All open timber work shall be painted on the back before being set in place.

Water-Table, Etc.—The water-table shall be (1¼ in. × 8 in.), having a (1¼ in. × 2½ in.) cap with a (¼-inch) tongue on its upper edge, and finishing with a (1 in. × 1¼ in.) *ogee* bed mold.

The belt between the clapboards and open timber work shall be (1½ in. × 8 in.), the under side to have a (¼-inch) rabbet, (1¼ inches) deep for clapboards. Finish with a (2 in. × 2¾ in.) beveled cap and (1 in. × 1¼ in.) bed mold. Put up (1⅛ in. × 6 in.) corner and angle boards scribed to the water-table cap, etc.

Siding.—Cover the frame, as shown on the drawings, with (*No. 1 clear white-pine beveled* siding) (6 inches) wide, laid (4½ inches) to the

weather, and nailed to every bearing with 6d. cut finishing nails. All joints shall be made on the studs only. Cut close, neat joints against all window and door frames, corner boards, etc. In all panels (18 inches) or under, the clapboards shall be put on in one piece, and no butt joints to appear in the first course over the window and door frames.

Veranda, Etc.—The veranda, porte cochère, and porch shall be constructed as indicated on the scale and detail drawings. Lay the floors with (1¼ in. × 3 in.) tongued-and-grooved *clear white pine*, blind nailed to every bearing, having the joints bedded in *white lead* and well driven up. The flooring shall be laid at right angles to the building and run full up to the sheathing. Work a rounded nosing on the edge of the veranda and porch floors. Run a (1¼ in. × 6 in.) skirting board around, and finish under the nosing with a bed mold. Construct the steps with (1¼-inch) treads and (⅞-inch) risers; finish steps with a rounded nosing and bed mold; the full dimensions are indicated on the plan.

The columns on the veranda and porte cochère shall be of *cottonwood* (10 inches) in diameter *in one piece*, turned, and having a plinth block with turned base and cap. The posts for the porch shall be (6 in. × 6 in.), chamfered and molded as indicated. Bore a (1¼-inch) hole through the columns for their entire length.

The top rail shall be molded and built up; the bottom rail to be solid, with beveled top and molded edge, as indicated. The balusters on the front of the building shall be (1½ inches), turned, and set (3½ inches) on centers; those for the porch to be (⅞ in. × 1½ in.), set (2 inches) on centers.

Construct strong lattice frames to be placed along the front of veranda, port cochère, and porch, to be constructed of (1⅜ in. × 3½ in.) sides and top rail, and (1⅜ in. × 5 in.) bottom rail, all mortised and framed together; the slats to be (1⅜ in. × 1⅜ in.), spaced (3¾ inches) on centers, and halved together at each intersection in a proper manner.

Ceiling.—Put up the veranda, porte-cochère, and porch ceilings level, with (½ in. × 3½ in.) tongued-and-grooved *clear North Carolina pine*, *center beveled*, the joints neatly fitted. Blind nail with 6d. finishing cut or steel wire nails; the ceiling to run at right angles with the front of the building.

Temporary Privy.—The mason shall excavate for, and the carpenter shall erect, as soon as work is commenced on the premises, a temporary privy at the rear of the lot, for the use of the workmen. The carpenter shall, at the completion of the work, remove the privy, and the mason shall clean out and fill the vault with fresh earth.

Clothes Posts.—Provide and set *four* (5-inch) *turned locust* clothes posts in the rear yard, at the points directed. The posts shall

be (8 feet) above ground and (3 feet 6 inches) below the surface; the lower part of the posts under grade to be left in the rough and stripped of the bark. Finish the posts with a ball turned on top and provide with *two* cross-pieces of *oak* (1¼ inches) in diameter to run through the post.

Fences.—Construct a picket fence along both sides of the lot (4 feet) high. Set up (5-inch) *squared and surfaced chestnut* posts (6 feet) apart; run between the posts *two* (2 in. × 4 in.) surfaced *white-pine* rails. The pickets shall be (1⅜ inches) square, pointed on top and spaced (2 inches) apart; run a (⅞ in. × 10 in.) surfaced *white-pine* base-board with (⅞ in. × 2 in.) beveled cap, and finish with (1½-inch) molded *white-pine* ribbons. The side fences at the front end shall, as indicated, be finished with a boxed post on top of the terrace slope. The rear fence shall be (4 feet) high with (5-inch) *square surfaced chestnut* posts, set (6 feet) apart, with rails, baseboard, and ribbons, the same as on the side fences. The pickets shall be (⅞ in. × 2½ in.), *round pointed* on top, and spaced (2½ inches) apart.

INSIDE CARPENTER WORK.

18. Having completed the specification of all the work and material for the rough part of the structure, there should follow the details of all the inside woodwork, generally termed "Interior Finish." The specific difference between these two divisions of the carpenter's contract is the distinction between carpenter work and joiner work as set forth in the sections on *Carpentry* and *Joinery*.

INTERIOR FINISH.

Finished Floors.—The upper or finished floors in the first and second stories shall not be laid until the plastering is completed; nor shall the material thereof be brought upon the premises until ready for laying, unless provision is made for its due protection from dampness, injury from lime, etc.

When the plastering has been entirely completed and the building thoroughly cleaned out, the carpenter shall lay *heavy-weight felt, resin-sized* paper, with a (3-inch) lap over the entire first and second story floors, except in the principal bathroom—the paper to run up to the partition walls on all sides of the rooms.

Lay over the paper a (1⅛ in. × 2 in.) tongued-and-grooved, *quartered white-oak* floor throughout the first story, well driven together and blind nailed. Lay the floor in the second story of (⅞ in. × 2 in.)

tongued-and-grooved, *comb-grained Georgia pine*, in like manner; fit the flooring neatly around floor registers, etc. All the stock in finished floors must be thoroughly kiln-dried and selected.

Cover the floors, as soon as laid, with a layer of heavy felt building paper, to protect them from heel marks and paint spots till the time arrives for finishing the floors. Before the last coat of paint or varnish is applied to the trim, etc., the carpenter shall plane down the floors of the first and second stories. He shall, besides, scrape and sandpaper the floor in the principal rooms of the first story and of all halls.

Window Frames.—All shall be made in accordance with the scale and detail drawings. The frames for masonry openings shall be boxed, as shown, with (2½-inch) *white-oak* sills, (1⅛-inch) casing, (1⅛-inch) blind hanging stile, (1⅛-inch) pulley stiles and heads, (⅞ in. × ½ in.) parting strips, and (⅞-inch) back lining.

The frames for double-hung sash in *first story* shall have (2-inch) sills rabbeted for siding, and (1-inch) subsills, (1⅛ in. × 4 in.) molded outside casings and heads with cap, (⅞-inch) blind hanging stiles, (1⅛-inch) pulley stiles and heads, and (⅞ in. × ½ in.) parting strips. The pulley stiles and parting strips for all double-hung windows shall be of clear *Georgia pine*, coated with *raw linseed oil* before leaving the shop. The frames shall have (1¾-inch) steel axle pulleys with face plates to match other hardware of the sash. The frames for hinged sash shall have (1¼-inch) rabbeted jambs and heads, with outside casings and blind hanging stiles, the same as the other frames. The window frames in the cellar, except those shown as double-hung, shall be constructed of (2 in. × 6 in.) *pine*, rabbeted for sash, and have (2-inch) *white-oak* sills, the sash to be hinged *on top*.

Sash.—The sashes for the first and second stories shall be (1¾ inches) thick; those for the *first* and *second story halls* shall be constructed of selected, clear, straight-grained *cherry*. The sashes for the *dining room* and *library* shall be of selected *comb-grained white oak*. All hard-wood sashes shall, before leaving the shop, be primed with paint on the outside. All other sashes in the first and second stories shall be of clear *white pine*.

The cellar and attic sash shall be constructed of clear *white pine* (1⅜ inches) thick. The upper sash of all double-hung windows shall have horns worked on the lower end of the stiles, as indicated on the details. All *pine* sashes which are to be painted shall be primed before leaving the shop. The sashes shall be well framed, mortised together, and pinned, and of a uniform thickness as specified.

Blinds.—Provide and hang blinds on all windows in the first story, the second story, and attic, except as otherwise indicated on the drawings. The blinds shall be made of (1⅛-inch) clear *white pine*, with rolling slats secured to rods with *copper* staples. The blinds on

wide windows—where shown—shall be *fourfold* with suitable *adjustable* fastenings. All blinds shall be hung with *wrought-iron* L hinges and have suitable catches on the walls of the building and on window sills. All blinds shall be primed with *white-lead and linseed-oil* paint, before being brought on the premises.

Door Frames.—The frame of the outside cellar door shall be constructed of (2 in. × 8 in.) *pine*, rabbeted for door, and shall have a (2½-inch) *white-oak* sill. The frame shall be solidly blocked away from the masonry jambs and well spiked to the wood plugs driven into the walls. The inside cellar door frames and outside first-story door frames shall be of (1¼-inch) *white pine*, rabbeted for doors. All inside door jambs in the first story, second story, and attic shall be (1⅛-inch) rabbeted for doors, those for halls to be of clear *cherry*, for *dining room* and *library* of *quarter-sawed white oak*. The jambs for all other inside doors shall be of clear *white pine*, those for sliding doors (⅞-inch) to match the finish of the rooms.

Doors.—All doors shall have raised panels molded to conform to the scale and detail drawings. The stock for all doors must be kiln-dried and free from sap or other defects. The *front* door shall be of *white pine* (2½ inches) thick, and the *vestibule* door (2¼ inches) thick; the doors from *hall* to *parlor*, *dining room*, and *library*, and from *parlor* to *dining room* shall be (2 inches) thick; all other doors in the first and second stories shall be (1¾ inches) thick, except closet doors, which shall be (1½ inches) thick. The outside cellar door shall be (2¼ inches) thick; the inside cellar doors (1¾ inches) thick; all the doors in the attic (1½ inches) thick.

All doors shall be constructed of wood to correspond with the finish of the rooms. The doors in the principal rooms of the first story, including *hall*, and the *hall* of the second story, shall have *white-pine built-up cores* and (¼-inch) *veneering*, all well glued up. Put (¼-inch) *pine veneer* on all doors that are to be *hard-wood veneered* on one side only; put *pine veneer*, also, on the inside of closet doors of rooms finished in hardwood.

Dutch Door.—The vestibule door shall have a horizontal rabbeted joint at the center, with striking pieces of *cherry* rabbeted and glued up to the core, the top of this door to swing in first.

All door panels wider than (8 inches) shall be built up, the grain and color of the wood matched; all shall be well jointed and glued together. The sliding doors shall have an astragal joint with hard-wood striking pieces. Construct all the necessary doors to the *dumb waiter*, *cupboards in pantry*, *kitchen*, etc. for *electric boxes*, etc., required or indicated, all to conform to detail drawings.

Saddles.—All doors, except sliding doors, shall have ($\frac{5}{8}$-inch) molded, *quartered-oak* saddles, well fitted around base, jamb, and plinth blocks.

Inside Trim and Base.—All windows and doors throughout the building, except in the cellar, shall be trimmed to conform to the detail drawings.

The halls in the first and second story shall be finished in selected clear *cherry;* the *dining room* and *library* in clear *quarter-sawed white oak.* All other rooms, closets, etc. shall be finished in clear *white pine*, unless otherwise specified. The trim in all the principal rooms in the first story, second story, and attic, including the halls, shall be (5 inches) wide, molded as shown on details. The trim in closets and inferior rooms shall be ($\frac{7}{8}$ in. $\times$ 4 in.) with plain mold on the jamb side. This mold shall be mitered and the body of the trim butt jointed. All door trim shall stop on the molded plinth blocks at the same height as the base. The back band and molding on the trim shall be mitered, and the facia jointed on a horizontal line.

All the windows in the principal rooms shall have molded panels below the stool; all other windows shall have stools and aprons molded to details. The base in the first story shall be ($\frac{7}{8}$ in. $\times$ 8 in.); that in the *kitchen* and *pantry* to be *beveled* on top. The base in the second story and attic shall be ($\frac{7}{8}$ in. $\times$ 6 in.), the *closet* base ($\frac{7}{8}$ in. $\times$ 6 in.), with *beveled* top. All bases shall be scribed to the floor. Where the base mold does not stop against the back band of the architrave, it shall have a return *worked on.*

Wainscoting.—Construct and panel the wainscoting as required by the detail drawings. The wainscot in the hall shall have a molded cap member to be coped in angles and mitered on corners. The dado shall be of the same altitude as the door architraves; the hall wainscot shall be continued up the stairs, rail high, continued around the second-story hall (3 feet 2 inches) high, up the attic stairs and around the attic hall (3 feet 2 inches) high.

All paneled wainscoting shall be ($1\frac{1}{8}$ inches) thick, the end stiles of each section extending down to the floor; and in long sections, *one* intermediate stile, at least, shall be carried to the floor. The wainscot in the *vestibule* shall be (4 feet) high. All hard-wood wainscot, before leaving the shop, shall be given a good coat of *pure raw linseed oil* on the reverse side.

Ceiled Wainscot.—Put up ($\frac{5}{8}$ in. $\times$ 2 in.) *beveled* tongued-and-grooved *white-pine* wainscoting, (4 feet) high, in *laundry*, *kitchen*, and *pantry*, finishing it with a molded cap and scribing it down on the base as required.

Wood Cornice, Beam Casing, Etc.—The frieze and cornice in the *hall* shall be of *cherry*, molded as required by the detail drawings. Case up the false ceiling beams, forming panels on ceiling, and continue the casing around the walls as well; set the bed molding and fit all neatly together. The flat surfaces of the panels shall be plastered.

Columns and Screen.—Build up the pedestals for columns with (1¼-inch) stiles and rails, panel to correspond with the wainscot; finish with top (1¼ inches) thick, on a line with the wainscot cap, the edge to be molded and finished with an *ogee bed* molding. Build up plinths for columns of the size shown, and veneer these plinths to cover all end wood. The base and abacus shall be molded and the cap hand carved, as shown on the full-size details. The shafts shall be built up on a *pine* core, with *seven* vertical pieces of *cherry* (1⅞ inches) thick, and shall be glued up and matched as to the grain and color of the wood. The shaft shall be turned to the proper entasis, and the flutes worked to a uniform width and depth. The spindles shall be (1½ inches), turned and spaced as indicated.

Hall Seats.—Construct the seats in the hall, library, and dining room as indicated, to have, as required by drawings, paneled fronts and ends, the tops hinging at the back. Line the inside with (½ in. × 2 in.) matched *white pine*.

Bookcases.—Set up bookcases in the library; to be built of *quartered white oak*, to the dimensions given, the ends to be (1¼ inches) thick, and paneled. Make the doors (1⅜ inches) thick, with rabbeted joints, and hinge; glaze with best clear *French plate* glass.

The cases shall have a molded cap and (1¼-inch) top with the edge molded as shown. The shelves shall be of clear *maple* (⅞ inch) thick, with a (¼-inch) molded *oak* front edge, glued on. Frame the backs of *maple*, with (⅞-inch) stiles and rails, and (½-inch) flush panels.

Carving, Composition, Etc.—Execute all carving as required by the drawings. All wood for carving shall be formed in the solid, matched as to color, and glued up, the carving to be done by hand. The finer lines of the carving shall be cut only after the work has been finally set in position.

The painter shall provide and set in place the composition ornaments as indicated on the drawings. The work on these ornaments shall be executed by a skilled modeler, strictly according to details, and the ornaments themselves set in position by a competent mechanic.

Picture Moldings.—Provide and erect the following:

(*a*) For parlor: a (⅞ in. × 1¾ in.) mold of *white pine*, with *composition* pearl and bead planted on. (*b*) For dining room and library: a (⅞ in. × 1½ in.) *quartered-oak* mold to match the trim of rooms. (*c*) For all

bedrooms in the second story: a ($\frac{7}{8}$ in. $\times$ $1\frac{1}{2}$ in.) *enriched gilt* molding. (*d*) For other bedrooms: a ($\frac{7}{8}$ in. $\times$ $1\frac{1}{4}$ in.) *plain gilt* molding.

All picture molding, except that perfected in gilt, shall, with the exception of the last coat, be finished by the painter before being put in place. It shall, likewise, be level and straight, and coped over the back band on trim.

Angle Beads.—Cover all plaster corners in the building with ($1\frac{1}{4}$-inch) turned angle beads (4 feet 6 inches) high, having turned and molded ends. All angle beads in rooms finished in hard wood shall be of the same material as the finish of the rooms; all others shall be of hard wood, finished to match other work.

STAIRS.

19. It is seldom that the contracting carpenter attempts to build the stairs for a building in his own shop. He usually entrusts this part of the work to some one who makes stair building his special vocation, and for this reason it is advisable to include all stair work under a separate heading.

Main Stairs.—Construct the main flight of stairs as indicated; the rough stringers to be (3 in. $\times$ 8 in.), and all stringers, platforms, and landings to be well framed together. The front strings shall be closed with a molded cap and paneled as indicated. All treads shall be ($1\frac{1}{4}$ inches) and risers ($\frac{7}{8}$ inch), tongued and grooved together, glued and wedged up; the treads, risers, and all platforms to be of *quartered white oak*. The treads shall have a molded nosing finished with an *ogee* bed mold. The wall strings shall be molded to correspond with the base. Panel the sides of the main flight down to the floor, and, likewise, under the rake and soffits with molded panels, to correspond with those on the wainscot and dado in the hall. The newel at the foot of the main flight shall be (7 inches) square, of *cherry*, boxed, paneled, molded, and carved as indicated. All other newels and posts of the main stairs shall be (5 inches) square, boxed, and finished in like manner.

The second-story flight to attic shall have closed strings with molded cap and paneled sides; rakes and soffits to be the same as in the main flight. All drop newels shall have molded and carved drops. The rails shall be (3 in. $\times$ 4 in.), built up, molded, and bolted together at the easements, and to all posts and newels. Each piece of rail shall be matched in color, straight grained, and have easements or ramps at all newels and posts. The balusters shall be of *cherry* ($1\frac{1}{2}$ inches), matched

as to color, to have square butts, and be *turned* and set *three* to each tread.

Rear Stairs.—The rear stairs from the first story to attic shall be strongly built with (2 in. × 6 in.) stringers and platform framing, and shall have (1¼-inch) treads and (⅞-inch) risers, tongued, grooved, and wedged together, as well as housed into the strings. The treads shall have a rounded nosing with a cove fillet under it. The wall strings shall be (1¼ inches) thick, molded to correspond with the adjoining base. The treads, risers, and platforms shall be of clear, selected *North Carolina pine*. The outside stringers are to be finished with a mold. The soffits of rakes and platforms shall be furred for plastering. The rails shall be (2 in. × 3 in.) of straight-grained *white oak*, *molded* as indicated. They shall have easements at the lower ends of rake sections, and shall be bolted together, and to the newels and posts as well. The balusters shall be (1 in. × 1⅝ in.), *three* to a tread. Sandpaper the corners, and dovetail the lower end of balusters to the treads, covering the joint with a nosing planted on, and mitering with, the nosing on the front of the treads. The newels and posts shall be (4 in. × 4 in.) *solid white oak*, chamfered, and the top molded, as shown on the detail drawings.

Cellar Stairs.—Construct strong plank stairs to the cellar; the stringers to be (3 in. × 10 in.) of dressed *spruce* plank; the treads to be (1¼-inch) and the risers (⅞-inch) *North Carolina pine*, housed into both strings and tongued and grooved together. Place a (4-inch) square, *solid oak* post at the foot of this flight. The upper rail shall be (2-inch) round *oak*, let into and bolted to the newel; the intermediate rail to be (1¼ in. × 3 in.) *North Carolina* pine—all to be well framed together and strongly built.

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20. To avoid confusion or misunderstanding in the selection of stock mantels, or such other fixtures as are manufactured in numerous designs and at various prices, an amount limiting the prime cost of each is usually stated in the specification in a way to be at once fair to the owner and the contractor. The mantels are often omitted from the specifications entirely, because, generally speaking, at the time the contract is signed, few, if any, of the detail drawings are prepared; or they are made the subject of a separate contract, the owner selecting designs from the manufacturer's stock, or requiring them to be especially designed by the architect. The same conditions apply also to gas fixtures, etc.

MANTELS.

The mantels shall be executed from designs furnished by the architect, or selected from the manufacturer's stock. The carpenter shall fit his work to the mantels in a manner productive of workmanlike results.

The mantel contractor shall furnish and set the mantels, *tile* hearths, facings, etc. (See specifications under "Masonry," Art. **12.**) He shall also furnish and lay a *marble mosaic* floor in the *principal bathroom;* a *marble* base (9 inches) high and (1¼ inches) thick; and a *Minton tile* wainscot (3 feet 9 inches) high, to finish with a molded *plaster* cap, run by the mason. The *mosaic floor* shall be set in and the joints grouted with *Portland cement* mortar; this floor shall be laid perfectly level, and the joints between the pieces kept to a uniform width. These joints shall be so well broken that no straight lines shall be visible. The body of the floor *mosaic* shall be of *white Italian* marble, the border (6 inches) wide of *brown Numidian* marble, the base of *dark Siena* marble, with the upper edge rounded.

CLOSETS, ETC.

Dumb Waiter.—The dumb-waiter shaft shall be framed perfectly plumb, the framing to be (1 inch) back of the line of the brick shaft in cellar, that the finished plaster in the shaft may come on a line with the face of the brickwork. Form a box for the weight and properly set the guides, attaching the face board of the weight box with screws. Frame *two* (4 in. × 8 in.) *dressed Georgia pine* timbers in the closet above attic floor to support the sheaves and mechanism, and set a suitable hinged door with all hardware for access to the shaft.

Provide and put in place a car (22 in. × 24 in.) and (3 feet 6 inches) high, with an *adjustable hinged* shelf in the center. This car shall be constructed of *oak* and strongly made, guaranteed to carry (1,000 pounds), and provided with all ropes and other appliances complete.

Closets.—Fit up the *butler's pantry* with a counter shelf (2 feet 3 inches) wide, of (1¼-inch) *white pine*, placing the shelf (2 feet 8 inches) above the floor. Put in cupboards with shelves, and (1¼-inch) sash doors, hinged, glazed with double-thick *American sheet* glass, and divided as indicated. Construct below the counter shelf *eight* drawers; the upper drawers to be divided for knives, forks, etc. Construct, also, closets, with hinged panel doors and one shelf. The cupboards shall be of the same altitude as the door trim, and finished with a neat crown molding. Fit the *pantry* sink with a (1¼-inch) grooved *oak* drip board; finish below the doors and drawers, making all conform to the detail drawings.

Kitchen Closet.—Fit up the kitchen closet as shown, with a (1¼-inch) counter shelf (2 feet) wide. Erect *five* (⅞-inch) shelves over the counter, and continue these around the closet. Support the shelves on (1 in. × 2 in.) cleats and with a (1½ in. × 1½ in.) standard at each corner. Divide the space under the counter shelf and hang the doors as indicated. To give access to barrels, hinge the end of the counter at the back; put in position, also, suitable hooks for pots, etc., as specified under "Hardware."

Provide the *laundry* closet with a counter shelf (20 inches) wide, with *two* drawers below, and erect *four* shelves above.

Linen Closet.—This closet shall have *six* large drawers (16 inches) deep, below the counter shelf; the counter shelf to be (1¼ inches) thick and (24 inches) wide, and extending around *three* sides. Build up *five* shelves (16 inches) wide above the counter, those on the sides to be enclosed with (1¼-inch) sash hinged doors, and (⅞-inch) *pine* framing, constructed like the cupboards in the butler's pantry; the shelves at the end of the closet to be open. Finish with a neat cap molding on line with the top of the door architrave.

Dressing-Room Closets.—The clothes closets in the *dressing rooms* shall be fitted up with *three* long drawers (16 inches) deep, below the counter, and with *four* shelves above it, enclosed with paneled, hinged doors (1¼ inches) thick. The clothes-hanging closets shall have *two* drawers near the floor and *one* shelf at a point (15 inches) below the top of the doors, which are to be paneled, hinged doors. Put in a (1¼-inch) *polished brass-pipe bar* for the support of clothes hangers, the *bar* secured to a socket at each end, as shown on the detail drawings. The hangers shall be furnished by the owner. Provide all bedroom closets, unless otherwise specified or indicated, with *two* drawers, a counter and one shelf above. The closets in the attic shall be fitted up in like manner. All closets shall, where practicable, have a neat clothes-hook strip with *bronze* hooks, spaced not more than (12 inches) on centers.

Wardrobes.—Construct and set in the *three* bedrooms not having built-in closets, wardrobes of *white pine*, with *two* drawers below, a (⅞-inch) shelf (15 inches) below top of door, and a clothes-hanging strip with *bronze* hooks. The doors shall be paneled and hinged. Finish with a cap to come on a line with the architraves of the room doors. The backs shall be *ceiled* with (⅝ in. × 2 in.) matched *white pine*, and the lower part of the sides cut to fit over the base. Each wardrobe shall have *four brass* casters with (1-inch) hard-wood or composition rollers. Provide the coat closet under the main stairs with a (⅞-inch) shelf and a hook strip with *bronze* hooks to conform to the other work.

Pipe Casing, Etc.—Case up all plumbing pipe lines above the cellar with ($\frac{7}{8}$-inch) boards of the same material as other woodwork wherein such casing is required. The fronts shall be removable and secured in place with *round-headed* screws. Secure the pipes where exposed to view to tack boards with molded edges. Do all the fitting of water-closet covers or seats, or any other fitting of woodwork required by the other trades. Provide and hang in each bathroom, where directed, a neatly molded *oak* strip with *four* bronze clothes hooks. Fit hard-wood beveled borders (2 inches) wide, mitered on corners, around all hearths.

Provide and set at the kitchen sink a ($1\frac{1}{4}$-inch) *oak* drip board, grooved as shown, and a splash back (18 inches) high, with a molded cap, securing the splash board with *round-headed brass* screws. Provide also and set a ($1\frac{1}{2}$-inch) *oak* frame for the kitchen sink and laundry wash trays. This frame shall be constructed solidly and secured properly. The covers for wash trays shall be constructed of ($1\frac{1}{4}$-inch) straight-grained *oak*, the end cleats to be (3 inches) wide, rabbeted, and the body of the covers built up in pieces not exceeding (6 inches) in width. Hang the covers with *brass* hinges, secured with *brass* screws. The wash trays shall be supported on a strong frame of (2 in. $\times$ 4 in.) surfaced *white pine*, framed together; the legs to be of *pine* (4 inches) *turned* as indicated.

Woodwork in Cellar.—Furnish the storeroom in cellar with a slat platform built for barrels (4 inches) high, made of (2 in. $\times$ 2 in.) *Georgia pine*, the strips spaced (1 inch) apart and secured to (2 in. $\times$ 4 in.) cross-pieces laid flat. This platform shall be built in two sections. Erect *five* ($\frac{1}{4}$-inch) shelves on *two* sides of the room, the lower shelf to be (3 feet 6 inches) above the floor, these shelves to be supported by (2 in. $\times$ 3 in.) *pine* standards placed at intervals of (4 feet). Construct a *slat* partition at the end of the storeroom to form a wine room; hang thereon a strong door made in like manner, attaching it with *heavy wrought-iron strap* hinges and providing it with a hasp secured with bolts and a *brass Yale* padlock with three keys. Put in the first shelf (3 feet 6 inches) above the floor and space the shelves above (9 inches) apart, the shelves to be of ($1\frac{1}{4}$ in. $\times$ 10 in.) surfaced *pine*. Place a ($\frac{7}{8}$ in. $\times$ 3 in.) strip along the front edge of each shelf with ($1\frac{1}{2}$-inch) half rounds, sawed out (4 inches) on centers, to receive the necks of bottles. Support the shelves on (2 in. $\times$ 3 in.) *pine* standards.

Coal Bins.—Construct two coal bins with ($\frac{7}{8}$ in. $\times$ $9\frac{1}{2}$ in.) matched *North Carolina pine* boards, well nailed to the framing. Frame the bins with (2 in. $\times$ 4 in.) *hemlock* to run to the ceiling and spaced (30 inches) on centers; the corners to be formed with two (2 in. $\times$ 4 in.) pieces spiked together. The bins shall have doors hung with strong

wrought-iron strap hinges, and provided with hasp and lock. Form a grooved guide and place removable slides on the inside of door jambs.

Cellar Water Closet.—Build a raised platform and enclose the water closet with ($\frac{7}{8}$ in. $\times$ 4 in.) matched *pine*, beaded and surfaced on both sides, the partitions to run from floor to ceiling. Lay the floor of ($\frac{7}{8}$ in. $\times$ 6 in.) *spruce* of the same quality as that used for the under floor in the first story. Construct a door with *three* (6-inch) battens, put on with screws, the door to be hung with (3 in. $\times$ 3 in.) loose pin butts, and provided with a suitable lock. Finish around the partition at the ceiling with a neat bed molding.

Swing Shelves.—Construct and hang *two* swing shelves where indicated on plan, these shelves to be (2 ft. $\times$ 8 ft.) formed of (2-inch) surface plank and supported from the ceiling on *two* ($\frac{3}{8}$ in. $\times$ $1\frac{1}{4}$ in.) *wrought-iron straps.*

Sash Glazing.—The cellar and attic sash shall be glazed with clear, *double-thick American sheet* glass, well tacked and puttied. All sashes in first and second stories shall, unless otherwise specified, be glazed with best *clear French plate*, well bedded, tacked, and puttied, or set with stops, as required by the detail drawings. The sash marked, "stained or metallic set glass," shall be *boxed and sent for glazing* to the address obtained from the architect.

The owner shall select the designs and pay for the stained glass, as well as the cartage and expressage thereon to and from the glazier's. The contractor shall be responsible for its safety from breakage while the glass is in the building, until the last payment on the work shall have been made.

Door Glazing.—The upper part of the vestibule door shall be glazed with *clear French plate* glass, well bedded and set in with stops.

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21. In order that the hardware manufacturer may readily determine the quality of goods required for each specified purpose, the section of the specification describing the hardware should be separated or kept apart from the other work, under a subheading.

HARDWARE.

All hardware shall be of (*The Yale & Towne Mfg. Co.'s*) manufacture, and shall all be furnished and placed in position by the contractor. The *vestibule*, *parlor*, *dining room*, and *library* shall have plain *Bower-Barff* finished hardware. All other hardware throughout

the building shall be, unless otherwise specified, of plain, *solid bronze*, secured with screws to match. The hardware in the cellar shall be of *iron, japanned.*

Door Hardware.—The front and vestibule doors shall have mortise locks, with plates, night latch, and keys, complete. The front door shall have a (3-inch) *mortise* bolt and a *bronze* push-button plate for bell. The vestibule door shall have *two* (3-inch) mortise bolts, top and bottom, one in each section; also one Dutch door bolt, between the sections, to match. All outside doors shall have *bronze* escutcheon plates. The kitchen and cellar outside doors shall have *steel* mortise locks with *bronze* fittings, and all other hardware to match. Provide a *combination* push button and speaking-tube mouthpiece plate of *bronze* at the kitchen door.

All sliding doors shall be hung with overhead *ball-bearing tubular* hangers, properly set with all fittings complete; the doors to be equipped with a sliding-door mortise lock; and with all fittings to match other hardware. The *double-acting* doors at the pantry shall have *double-acting check-spring* hinges, and plain *bronze* push and *kick* plates. All regular doors throughout the building, except the closet doors in the second story and attic, shall have mortise locks, with all furniture complete. All closet doors in the second story and attic shall have *rim* locks on the inside of doors, with furniture to match other doors. The pantry closet, cupboard, clothes closet, and wardrobe doors, shall have suitable locks, etc., while all drawers shall be provided with locks, buttons, and pulls to match other hardware.

Hinges.—Hang the front door with *three* ($4\frac{1}{2}$ in. $\times$ $4\frac{1}{2}$ in.) loose pin butts; the vestibule door with *two* (4 in. $\times$ 4 in.) loose pin butts *to each section;* all principal doors of ($1\frac{3}{4}$ inches) thickness, or over, with two (4 in. $\times$ 4 in.) loose pin butts. Provide loose pin butts for all ($1\frac{1}{2}$-inch) doors ($3\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in.), and for all other doors of the requisite sizes demanded. Hang all cupboard doors, wardrobe doors, etc. with butts to match other hardware; and provide and set all other butts or hinges required to finish the work as specified or indicated.

Bolts and Keys.—The front and vestibule doors shall be provided with bolts as hereinbefore specified. The kitchen outside door shall have a (4-inch) *mortise* bolt; the outside cellar door shall have a (4-inch) *wrought-iron-barrel* bolt. All outside doors shall have *three* keys; all other doors in the building *two* keys.

Sash Hardware.—All double-hung sashes shall have burglar-proof sash locks of an approved design; the lower sash to be provided with *two flush-plate* sash lifts, attached with *brass* screws. All double side-hinged sashes shall be hung with loose pin butts and be provided with top and bottom *combination spring* bolts, with a *lever* handle and

suitable lock. The single side-hinged sash shall be hung in like manner and provided with a *spring* sash lock having a *lever* handle. The single sash in the cellar shall be attached *on top* with two hinges, and be provided with a *spring* lock, and a suitable hook and staple. Provide and put in place all hardware required, including that in the kitchen, whether specifically mentioned herein or not, in a manner to finish the work fully, and to leave it in good order for use.

Door Stops.—All doors throughout the building shall, unless otherwise specified, have hard wood, turned door stops, with rubber nibs for walls and rubber cushion for floor stops. The door stops for front and vestibule doors, as well as those for halls, parlor, library, and dining room, shall be of *metal*, turned and finished to harmonize with other hardware, and provided with rubber nibs. The stops in those rooms having *bronze* hardware shall be *solid bronze*, turned.

Hooks.—Provide and set *bronze* clothes hooks in all closets, and wardrobe hooks in wardrobes and closets in the second story and attic, all spaced not more than (12 inches) apart. Also provide kitchen closet with suitable pot hooks as well as other hooks required.

Blind Hardware.—Hang all outside blinds with *wrought-iron* L hinges, made to throw the blind clear of the outside casing. Put on all fasteners and attachments required to leave the blinds in good working order.

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22. Tinning and tinner's work are usually included in the plumbing contract, though when the amount of work in these trades is small, it is customary to include the flashing, etc. in the carpenter's contract, leaving to his discretion who shall perform the work.

The same may be said regarding the ironwork, though this is as often included in the mason's contract, especially where it includes only such details as gates, gratings, etc. If there is much ironwork, however, it should be specified in a separate contract.

TINNER'S WORK.

The tinner shall furnish flashings of *N. & G. Taylor's "old style"* tin, painted on both sides, as follows: (*a*) **Gutter flashings** to run (8 inches) under the shingles. (*b*) **Chimney flashings** to run (6 inches) under the shingles and well up on all sides of the chimneys. (*c*) **Apron flashings** to be cut on a line with, and (1 inch) from, the shingles; these to be furnished the mason and built in by him.

(*d*) **Dormer flashings** to run (6 inches) under the shingles, and up (8 inches) on the face and cheeks. (*e*) **Hip** and **ridge flashings** to extend (7 inches) on each side. (*f*) **Valley flashings** to extend (10 inches) on each side.

Put up flashings also over all window caps or other wood projections, running the tin (6 inches) under the clapboards or other outside finish, dressing down the edges and nailing securely. The flashing on the belt-course cap shall not extend under the plaster finish. The tinner shall lay all the flashings, except the apron flashing on chimneys, when notified by the carpenter to do so. Fasten all well, with tinned wire nails, making a neat and water-tight job. All tin shall be well locked together, having the joints soldered with half-tin-half-lead solder, using resin as the flux. All resin shall be cleaned off before paint is applied.

Gutters.—Line the gutters, as formed by the carpenters, with tin, as herein specified, neatly dressing it down, leaving no sags, turning the edges over moldings, and tacking down smoothly. Form tubes at the outlets, flare on top and solder well to the gutter. The paint used for tin shall be composed of the best metallic paint, ground in pure linseed oil. (See specifications under "Painting," Art. **27.**)

Leaders.—Furnish and place in position, at the proper time, *nine corrugated galvanized-iron* leaders, at the points indicated on the drawings. The principal leaders shall be ($3\frac{1}{4}$ in. $\times 4\frac{1}{8}$ in.); those for veranda, etc. to be ($2\frac{1}{8}$ in. $\times 2\frac{3}{4}$ in.), all having the necessary offsets, and the principal leaders provided with square, molded leader heads, as indicated. Cover the openings to the leaders with *galvanized-iron* wire baskets, and secure the leaders to the building by means of *ornamental galvanized wrought-iron straps*, secured with *brass round-headed* screws; the straps to be spaced not more than (6 feet) apart. The lower end of the leaders shall be crimped and fitted to the drain pipe, using cement to make the joint tight.

IRONWORK.

Provide and set wrought-iron gates and fittings complete, as required by the detail drawings. Provide and set, at the proper time, all area gratings, window guards, coal-chute covers and frame, etc., to conform to drawings. All anchors, hinge and catch hangers for *ironwork* in ashlar or other limestone, shall be of *bronze*, leaded in. The owner shall provide, and the plumber shall fit up in good working order, a wrought-iron lamp at the porte cochère.

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23. Under the general heading of "Plumbing" should be included all the work and material pertaining to the

plumbing work in the building. Sometimes the heading is extended to include gas-fitting, as both these trades are usually practised by the same mechanics.

As the lines of pipes and the location of traps are not usually shown on the general drawings, it is necessary to describe in detail all the work to be done by the plumber, in order that he may prepare his estimate intelligently.

PLUMBING.

All excavation and filling-in required for the plumbing work shall be done by the mason. The carpenter shall do all necessary cutting of timbers or other woodwork, but the plumber must notify each when such excavation, filling-in, or cutting is required; and no timber shall be cut unless absolutely necessary. With reference to all work not covered by the specifications and drawings, the plumber shall be governed by the rules and regulations as to plumbing and drainage established by the local authorities.

The plumber shall furnish all materials and perform all requisite labor for the execution and completion in a workmanlike manner of all plumbing in accordance with the plans and specifications. All materials shall be of the best, free from defects of any kind. The mason shall close all pipe openings in walls and ceilings, and the carpenter shall close all pipe openings in the floors, after the pipes are set in position and tested.

Cast-Iron Pipe.—All cast-iron pipes and fittings shall be sound, smooth on the inside, cylindrical, free from cracks or sand holes, of uniform thickness, and of average weight per foot in (5-foot) lengths, as follows:

Diameter.	Weight per Foot.
2 inches	5½ pounds.
3 inches	9½ pounds.
4 inches	13 pounds.
5 inches	17 pounds.
6 inches	20 pounds.

All branch connections in the cast-iron pipe shall be made with Y branches and obtuse-angle bends, except as otherwise specifically mentioned and defined. All cast-iron pipes shall be coated with *asphalt* outside and inside, after they have been tested at the foundry.

Joints in Cast-Iron Pipe.—All joints in the cast-iron pipes shall be made with picked oakum and molten lead, calking the joints well and bedding the oakum in the joints to a point (1½ inches) below

the top of the hub. Run in the molten lead, filling the joint, and calk the lead firmly in place with hammer and calking iron. Each joint shall have at least *twelve* ounces of lead to each inch of the pipe's diameter. No putty or cement joints of any kind shall be permitted.

Lead Pipe.—All branch lead, soil, waste, and vent pipes and all lead bends shall be of the best quality and of the following weight per lineal foot:

Diameter.	Weight per Foot.
1½ inches	3 lb. 8 oz.
2 inches	4 pounds.
3 inches	6 pounds.
4 inches	8 pounds.

All connections between lead and iron pipes shall be made with heavy brass ferrules, having an inside diameter slightly larger than the outside diameter of the lead pipe: to be set in the hub of the iron pipe and calked with picked oakum and molten lead; the lead pipe to be attached to the ferrule with a good wiped solder joint. All connections between lead pipes shall be made by wiped solder joints.

Tests.—The foreman plumber, or person in charge of the plumbing work, shall stop up all outlets and inlets in the iron and lead pipes comprising the vent and drainage system, including all branches and connections, in the presence of the architect and the inspector of the local building or health department. Test the system, then, by filling the lines with *water*. Should any bad leaks occur in the joints, necessitating the emptying of the pipes, they shall be refilled, and, after the leaks have been stopped, again tested. Any lengths of pipe or fittings showing cracks or sand holes should be removed, and a new length of pipe or fitting inserted, without the use of short lengths of pipe, collars, or double hubs.

Earthen House Sewer.—The plumber shall lay the house sewer from the outside of the foundation wall to a point (5 feet) or more from the cesspool, of salt-glazed, vitrified earthen pipe, cylindrical and straight, and not less than (¾ inch) in thickness. The sewer shall be run with a uniform grade of not less than (¼ inch) to the foot; the trench to be leveled evenly its entire length, and the pipes thoroughly laid and bedded so that no sags can occur. All joints to be made with *hydraulic Portland* cement as specified for other drains. The ends of each length of pipe shall be wetted before laying. Pack the earth well on each side of the pipe, taking care, however, not to crack any of the joints.

Main Drain Trap.—The plumber shall set a (4-inch) cast-iron running trap at the point indicated in the trap pit, having a handhole, with a brass ferrule and screw cap calked into each hub. Calk on the outlet end of trap sufficient cast-iron pipe to run at least 5 feet outside the foundation wall, and connect there with the earthen sewer pipe.

Fresh-Air Inlet.—Put in a fresh-air inlet of *cast-iron* pipe (4 inches) in diameter from the inlet side of the main drain trap to the point indicated on the drainage plan, and extend the pipe upwards (10 inches) above grade, finishing with a suitable *cast-iron* cap.

House Drain.—Put in the house drain from the main drain trap, along the cellar wall as shown, running at a uniform grade of ($\frac{1}{4}$ inch) to the foot. Continue the line beyond the inlet for risers, as shown, and finish with a brass ferrule and screw-cap.

Area Drains.—Provide and set in position a (6 in. $\times$ 6 in.) cast-iron *bell* trap and strainer for each window area and the cellar entrance area, the mason setting it properly in position and working the concrete around it. The window area drain shall be connected to the leader drain by (3-inch) salt-glazed vitrified pipe; the pipe to be connected to the bell trap and laid so that the joints shall run in the direction of the flow. All connections shall be made with Y branches and bends, and the joints cemented together. The cellar entrance area shall discharge into a dry cesspool, as specified under "Masonry."

Soil Pipe.—Place a cast-iron soil line, connecting with the house drain by a Y branch and bends, and extending full caliber to a point (3 feet) above the roof. The soil line shall have (4-inch) Y branches for water closets, and (2-inch) Y branches for other fixtures. Connect with the above described Y branches, (4-inch) *lead bends* for water closets and short lengths of (2-inch) *lead pipe* for other fixtures, except where otherwise specified or where running lines of waste pipe occur, in which case the fixtures shall be attached to the soil line, through lengths of (2-inch) *cast-iron* pipe where not exposed to view.

Waste Pipes.—Fit up the main waste line, as shown, of (3-inch) cast-iron pipe for the kitchen, laundry, and pantry fixtures; connect with the house drain and extend at least (3 feet) above the roof; put in a (3 in. $\times$ 4 in.) increasing fitting inside the roof line, and extend above with a length of (4-inch) cast-iron pipe. The waste pipe shall have (2-inch) Y branches on each floor, and each of the fixtures on this line shall be connected with short lengths of (2-inch) *lead* pipe, as shown, unless otherwise specified.

Vent Pipes.—Fit up (2-inch) *galvanized wrought-iron* vent lines with (2-inch) branches for water closets, and ($1\frac{1}{2}$-inch) branches for other fixtures, as indicated on the plans. Connect by short lengths of *galvanized wrought-iron* pipe and *nickel-plated brass* pipe where exposed, (2 inches) in diameter, with the crown of each water-closet trap, except the vent pipe in the cellar, which shall be connected to the closet with (2-inch) *lead* pipe and brass solder nipple. Put in for all other fixtures ($1\frac{1}{2}$-inch) *galvanized wrought-iron* branches, with *nickel-plated brass* where exposed to view. Extend the main vent line up to the

roof, increasing it to (4 inches) in diameter and carrying it up at least (3 feet) above the roof. The vent line for the waste-pipe stack shall be connected to the waste stack at a point above the highest fixture. The vent lines shall be connected to the soil or house drain below the lowest or last fixture on the line, with a bend and Y-branch connection.

Arrangement of System.—The pipe lines throughout the building shall be so arranged and placed in order to be as direct as possible, avoiding all offsets or unnecessary bends, all to be graded so as to discharge freely; and all horizontal lines of waste and vent pipes to be given a good grade towards the outlet. The joints between the pipe lines and the roof shall be made tight with a (6-pound) sheet-lead flashing turned into the pipe hub and dressed down smoothly all around; the joint to be calked in the same manner as other joints in the cast-iron pipe throughout the building; each pipe extending above the roof shall have a globe wire-basket strainer at the opening.

Leaders.—The tinners shall furnish and fit up all leaders and connect them with the drains.

Safes.—Provide and set (1¼-inch) *countersunk Italian marble slabs* under the water closet, bath tub, and lavatory in the *principal* bathroom, and under the water closet, bath tub, and *slop* sink in the *servants'* bathroom. Provide each safe with a flush *nickel-plated* strainer over the outlet. Place under the water closet in the cellar a safe of (6-pound) *sheet lead*, dressed down to the frame set by the carpenter. This safe shall *not* be drained.

Safe and Refrigerator Waste.—Connect all safes with (1¼-inch) D *lead* branches, to discharge into a main safe waste of (1½-inch) *galvanized wrought iron*. This line shall discharge openly over and into the cellar sink. The joints between the *lead* and *iron* safe wastes shall be made with brass soldering nipples, threaded for iron and connected with a wiped solder joint to the *lead* pipe. The refrigerator waste shall be of (1¼-inch) *galvanized wrought iron* and shall discharge separately into cellar sink, a safe waste trap being located near the refrigerator. The special refrigerator trap, which traps the cold air, must discharge openly into said safe waste trap.

Traps.—Trap all fixtures in the building in the manner shown on the plumbing plans—all to be accessible and as near the fixtures as possible. The traps shall be of the diameter and materials as follows: (*a*) For water closets, (4-inch) trap and bowl combined. (*b*) For bath tubs, (2-inch) *lead, under floor.* (*c*) For lavatory, (1¼-inch) *nickel-plated brass, above floor.* (*d*) For wash trays, (2-inch) *brass* (no plating). (*e*) For *butler's* sink, (8-inch) *brass, chilling grease trap, screw top.* (*f*) For kitchen sink, (8-inch) *brass, chilling grease trap, screw top.* (*g*) For *cellar* sink, (2-inch) *lead.* (*h*) For *slop* sink, (2-inch) *brass, nickel plated.*

All traps, except those for the *butler's* and kitchen sinks, shall be of the same weight and diameter as the branches to which they are attached. The connection between the water-closet traps and *lead-bend* outlets shall be made with a heavy brass floor flange, set in *red lead* and bolted down tight. The vent connections with the water closets shall be made perfectly gas-tight by means of *red lead* and properly faced flanges.

Cisterns.—The plumber shall provide and set on *nickel-plated* brackets over the water closet in bathrooms, a cistern (10 in. × 12 in. × 18 in.) in size, lined with (16 ounces) *planished copper*. The cistern in the *principal* bathroom shall be cased *by the carpenter* in *quartered oak* to harmonize with the trim of the room. The cisterns for *servants'* bathroom and *cellar* closet shall be selected by the architect from manufacturers' catalogue. The brackets shall be fastened to a board, which will be set by the carpenter. The plumber shall connect the bathroom cisterns with (½-inch) supply and (1¼-inch) flush pipes of *nickel-plated brass;* the flush pipe to discharge into the closet bowl. The cistern in the *cellar* shall be supplied through (½-inch) A A *lead pipe*, the flush pipe to be (1¼-inch) D *lead*, discharging into the closet bowl. Provide a suitable *nickel-plated* chain and pull for each closet cistern.

Furnish and fit up over the *slop* sink, at proper height for a good flush, a (6-gallon, 16-ounce) *copper-lined oak* cistern, supported on *nickel-plated brass* brackets and provided with (1-inch) *nickel-plated brass* flush pipe, *nickel-plated* chain, and *oak* pull complete.

Fixtures.—Furnish and fit up complete, in good working order, the following fixtures, hereinafter described:

(*a*) Water closets: One in *principal* bathroom; one in *servants'* bathroom; one in *cellar*.

(*b*) Bath tubs: One in *principal* bathroom; one in *servants'* bathroom.

(*c*) Lavatory: One in *principal* bathroom.

(*d*) Slop sink: One in *servants'* bathroom.

(*e*) Sinks: One in *butler's* pantry; one in kitchen; one in cellar.

(*f*) Wash trays: A set of *three* in *laundry*.

(*g*) Boiler: One in kitchen.

(*h*) Refrigerator: One in pantry (to be furnished by the owner).

(*i*) Kitchen range and laundry stove shall be furnished and set by owner.

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24. Here should follow, under a subheading, a complete and detailed description of every fixture required in the building, giving, where possible, the manufacturer's name and the catalogue number, if such can be obtained.

DESCRIPTION OF FIXTURES.

Water Closets.—Provide and set in the principal bathroom an all-porcelain siphon-jet water closet of the best quality, American make, with flushing rim, complete, finished plain white, embossed; to be approved by the architect. This closet shall be provided with a *quartered-oak* seat and cover, both secured *to the bowl;* all fittings to be of *brass, nickel plated.* The closet, with seat, cover, cistern, supply and flush pipes, and pull, complete, together with *countersunk Italian marble safe slab*, to cost ($87.00, net).

Set up in the *servants'* bathroom an all-porcelain front-outlet, washout, flushing-rim closet, provided with *oak* seat and cover secured *to the bowl.* All fittings shall be of *brass, nickel plated.* This closet, complete, with *countersunk marble safe slab*, cistern, etc., to cost ($50.00, net).

Set up in the cellar an all-earthenware, front-outlet, washout, flushing-rim closet, provided with *oak* seat, cover, and back. All fittings on the seat and cover shall be of *brass*, the flush and supply pipes to be of *lead*, supported by hard metal tacks soldered to pipe and secured to board with screws. This closet, with cistern and all fittings complete, to cost ($30.00, net).

Bath Tubs.—Provide and fit up in the *principal* bathroom a *porcelain roll-rim Roman* bath (5 feet 6 inches) long, decorated outside in *Delft* design with all necessary *nickel-plated brass* supply and waste fittings above the floor, having a *nickel-plated standing* waste, shut-off valves and floor flanges, complete, and *china* handles on waste and supply valves. The bath shall be supported on *glazed porcelain* legs.

Set up a *nickel-plated brass* combination *needle*, *shampoo*, and *shower*, the *shower* to be (8½ inches) in diameter and provided with a *thermometer* and *safety mixing chamber;* also a *white rubber curtain* and attachments, complete; provide and set up a neat *nickel-plated brass* sponge holder, *china* soap cup with *nickel-plated* holder, and a combination towel shelf and rack (26 inches) long; the bath and appurtenances complete, with *countersunk Italian marble floor slab*, to cost ($350.00, net).

Provide and set in the *servants'* bathroom a *porcelain-lined iron roll-rim* plain bath (5 feet 6 inches) long, supported on *enameled-iron legs*, having a *nickel-plated brass standing* waste, and (¾-inch) *brass, nickel-plated* hot and cold supply pipes to floor. Provide, also, and set up a *nickel-plated* sponge holder, *china* soap cup with *nickel-plated* holder, and a *nickel-plated three*-bar swinging towel rack. This bath with *countersunk Italian marble floor slab*, complete, to cost ($110.00, net).

Lavatory.—Provide and fit up a lavatory with *Italian marble countersunk slab* (33 in. × 24 in. × 1¼ in.), a (16-inch) *back* and (5-inch)

aprons, *nickel-plated brass* legs and apron brackets, *oval* basin (19 in. × 15 in.) *ivory-tinted*, *nickel-plated combination* supply valves, with *china* handles, *nickel-plated* hot and cold supply, and waste pipes to the floor, with floor slab, complete, to cost ($75.00, net).

Slop Sink.—Provide and set up a *porcelain-lined cast-iron flushing roll-rim slop* sink (24 in. × 20 in. × 12 in.) in size, with *combination trap*, *standard*, (3-inch) *nickel-plated brass* plug and strainer; having, also, a *nickel-plated* hot and cold combination *lever-handle* faucet and *nickel-plated* supply and flush pipes.

Kitchen Sink.—Provide and fit up in the kitchen a *porcelain roll-rim* sink (42 in. × 24 in. × 7 in.) with a (2-inch) *brass* coupling, strainer, and (2-inch) waste. This sink to have a *brass chilling grease* trap (8 inches) in diameter, with a 1½-inch *brass* vent, the sink to be supported on *polished brass legs*, and supplied with hot and cold water through finished brass faucets, with *lever* handles.

Pantry Sink.—Provide and fit up, on framework erected by the carpenter, a *porcelain pantry* sink (24 in. × 17 in. × 6 in.) in size, with *brass nickel-plated* strainer and rubber plug, with chain; having, also, a (2-inch) *brass* waste and (8-inch) *brass chilling grease* trap with (1½-inch) *brass* vent. This sink shall be supplied with hot and cold water through a *nickel-plated compression combination goose-neck pantry faucet*, with a *china name plate* on each valve.

Sink in Cellar.—Provide and fit up in the *cellar* a *galvanized cast-iron* sink (28 in. × 20 in. × 6 in.) in size, with overflow and *brass* strainer. This sink shall be supported on *galvanized-iron legs* and have a (2-inch) *lead* waste and **S** trap and a (1½-inch) *lead* back-air pipe. It shall be supplied with cold water only, through a (¾-inch) *galvanized-iron* pipe and (⅝-inch) brass compression bib.

Wash Trays.—Provide and set up in *laundry* a set of three *porcelain enameled earthen* wash trays, each (30 in. × 25 in. × 14 in.) in size, supported on a strong wooden frame and *turned* wooden legs, set by the carpenter, who shall also furnish and set a *hard-wood* frame and covers, as hereinbefore specified. The wash trays shall have brass plugs, with chain, and brass strainers; waste through a (2-inch) *brass* pipe and trap, with a (1½-inch) *brass* back-air pipe, all *nickel plated on the rough;* supply with hot and cold water through a (¾-inch) *galvanized-iron* pipe, and (⅝-inch) finished brass faucets, with *lever* handles.

Boiler.—Provide and place in the kitchen a (60-gallon) *seamless copper* boiler, tested to withstand a pressure of (150 pounds), reinforced on the inside, and having a heavy *copper* dome. This boiler shall be connected with the waterback of the range by a (1-inch) seamless

drawn *brass* pipe, with *brass* couplings and bends, complete. Put in a (¾-inch) sediment pipe of *brass*, with round way stop-cock under the boiler; continue with a (¾-inch) *galvanized-iron* pipe, to discharge into *cellar* sink.

Refrigerator.—The owner shall furnish, and the plumber shall set, where shown, a refrigerator, and discharge its waste pipe over *cellar sink*, as specified.

Water Supply.—The entire premises will be supplied with water from the local water-works system. The main runs (6 feet) below the street on which the building fronts. The distance between the street main and the front cellar wall is (75 feet); the average depth required for the house service pipe is (5 feet 6 inches); the soil is assumed to be about 50% *hard pan* and 50% *loam*. The mason shall excavate and refill the trench for the water service pipe, and a tapper duly authorized by the local authorities shall, at the plumber's order, tap the street main, placing a (¾-inch) corporation cock at or near the point indicated, or as directed by the architect. The plumber shall lay on a solid bottom, and with a uniform grade down to the cellar, a (1-inch) A A A *lead* pipe, extending through the cellar wall. This pipe is to be protected externally with tarred felt where it passes through the wall, and a (1-inch) round-way extra heavy stop-cock, extension key rod, and cast-iron extension curb box of approved make, to be located at the curb; on the cellar end of this (1-inch) lead pipe wipe a brass solder nipple, and connect this to a (1¼-inch) lever-handle round-way stop and waste cock, with a (1¼ in. × 1 in. × 1¼ in.) reducing **T** and plug between. From this stop and waste cock run a (1¼-inch) line of *galvanized-iron* pipe along the cellar ceiling until the first riser is reached; here it will terminate with a (1¼ in. × 1 in. × 1 in.) reducing **T**. On the house side of the stop and waste cock, take off a branch and continue it with a (¾-inch) *galvanized-iron* pipe to supply a (¾-inch) garden-hose bib under the veranda, where shown on the elevation; place a (¾-inch) stop and waste cock in the cellar, clear from frost; grade this pipe back from the hose bib to the stop and waste cock.

From the (1¼-inch) reducing **T** aforesaid, run a (1-inch) branch to supply a (¾-inch) rising line to the bathrooms, and a (¾-inch) branch for laundry tubs. At the base of the riser, place a (¾-inch) stop and waste cock, and on the laundry tubs branch, place another (¾-inch) stop and waste cock. Run a (¾-inch) *galvanized-iron* riser up to the bathrooms, leaving off the necessary branches to supply cold water for each fixture; finish the top of the riser with an air chamber (6 feet) long. All exposed parts of this riser and its branches to be of *brass* pipe, *nickel plated*, and all wall and floor intersections to be covered with *nickel-plated brass* escutcheon plates.

From the (1¼-inch) reducing **T** aforesaid, run a (1-inch) *galvanized-*

iron pipe directly to the boiler and connect full size to its cold-water inlet tapping with a (1-inch) lever-handle stop and waste cock, close to the boiler. From this pipe run a ($\frac{3}{4}$-inch) branch to the kitchen and cellar sinks. Connect the boiler to the range with (1-inch) *brass* pipe and ground unions. From the top of the boiler run a (1-inch) *galvanized-iron* hot-water distributing pipe up to the *principal* bathroom, leaving off branches for the several fixtures. Then reduce and continue up with ($\frac{3}{4}$-inch) pipe to *servants'* bathroom, leaving off branches here; from the highest point return directly back to the boiler with a ($\frac{1}{2}$-inch) *galvanized-iron* pipe; connect this to the bottom of the boiler. Place a (1-inch) stop-cock on the hot-water pipe from the boiler, and place a ($\frac{1}{2}$-inch) stop-cock on the circulation pipe. From a point on the (1-inch) hot-water pipe, and between the top of the boiler and the stop-cock, take off a ($\frac{3}{4}$-inch) branch to supply hot water for kitchen sink and laundry tubs; place a ($\frac{3}{4}$-inch) stop and waste cock on this branch. Air chamber the pipe on the top of the boiler with air chambers (3 feet) long; arrange the stop-cocks in a neat and symmetrical manner; all pipes in the kitchen to be exposed and screwed on the face of pipe boards to be furnished and put in by the carpenter. The branches to the fixtures shall be as follows:

For baths, ($\frac{3}{4}$-inch).
For water-closet cisterns, ($\frac{1}{2}$-inch).
For lavatory, ($\frac{1}{2}$-inch).
For all sinks and wash trays, ($\frac{3}{4}$-inch).

Pipe Supports.—All pipes running under the cellar ceiling shall be supported therefrom; cast-iron pipe, by strong wrought-iron *adjustable* hangers; water supply and other pipes, by solid metal straps. All pipes running along the cellar walls, and all standing lines, shall be supported by heavy *galvanized wrought-iron* hooks, (5 feet) apart. Pipes running between the floor joists shall be uniformly supported on suitable shelves, to be furnished and put in by the carpenter, under the plumber's direction.

All exposed supply pipes in the kitchen, laundry, and pantry shall be supported neatly and equidistant, by tinned straps, secured by *round-headed* screws to the pipe boards. The plumber shall grade each supply pipe line so that when the water is shut off, the line shall be completely drained; each rising line to be provided with a stop-cock so that any one may be controlled independently of the other.

After the plumbing system is finished and the traps all sealed with water, an approved smoke test must be applied for the architect's satisfaction. This final test must be made satisfactory, also, to the local inspector of plumbing. The plumber shall obtain the permit for and turn on the water. He must go over the work and see that every joint and connection on the premises is perfectly tight and the system in good working order.

25. As said before, the gas-fitting is usually included in the plumber's contract, but to facilitate his work it should be separated under a subheading. However, if the gas-fitting is separated from the plumber's work entirely, it should be described under a general heading, as in the other trades.

GAS-FITTING.

Gas-Fitting.—The entire premises shall be supplied with gas from the local gas works, the tap to be made on the main under the street on which the building faces. The service pipe, from the street main to the inside of the front property line, shall be put in by the local gas-light company, which shall, also, at the proper time, place the meter in position, making connection with it on the inlet side. The gas-fitter shall lay a (1¼-inch) *galvanized* wrought-iron main, covered outside with asphalt paint, from the front property line to the inside of the cellar wall, and up to the point at which the meter shall be placed. He shall attach a heavy brass stop-cock to the main, inside the cellar wall. He shall, likewise, continue the main of (1¼-inch) and the risers of (¾-inch) wrought-iron pipe. All branches shall be taken from the side or top of the running lines. All running lines shall be free from sags or traps, and all graded towards the meter at the front cellar wall. There shall be, in all, 96 gas outlets. All side lights in the first-story rooms and halls shall be (5 feet 9 inches) above the floor, and all other lights (5 feet) above the floor. All nipples for drop lights shall be set perfectly plumb, and centered in the rooms. In putting up drop-light nipples, screw on a long piece of pipe and plumb it, after which the pipe may be removed. All nipples for side lights shall project (1½ inches) from the studs for plastered walls, and shall be set perpendicularly to the walls. All side lights shall be supplied through a (⅜-inch) pipe; the drop lights in the dining room through a (½-inch), and all the other drop lights through a (⅜-inch) pipe.

Place in due position a (¾-inch) pipe for the *gas* range in kitchen, making all connections thereto. All pipe ends shall be reamed, and the joints shall be screwed up with red lead, the outlets capped up, and the system proven tight by the *mercury* test. No split pipe, nor damaged or inferior material of any kind, will be accepted or allowed. The gas fixtures shall be furnished and put up by the owner.

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26. Heating is usually the subject of a separate contract, though sometimes it is included in the plumber's work. In either case it should be separated under a distinct heading and every detail carefully described.

HEATING.

The building will be heated with a *hot-air* furnace, by the natural-draft system. The heating contractor shall furnish the best of materials and workmanship to execute his work in a substantial manner, according to the drawings and this specification. The work shall conform to the laws and regulations of the local building department, or civic ordinances, and also to the rules of the fire underwriters.

The carpenter shall do all cutting of timbers required, and the owner shall furnish the necessary fuel to test the efficiency of the plant.

The contractor shall give all necessary measurements or information required by the mason, to enable the latter to build the furnace pit, brick furnace enclosure, cold-air duct, and to set iron door frames.

Furnace.—Provide and set up in the cellar, where shown, a *cast-iron* furnace, having a sufficient grate area and heating surface to furnish sufficient heat to properly warm the several rooms, with an ordinary amount of attention, during *zero* weather. The furnace shall be brick-set by the mason, and provided with the necessary clean-out doors, etc., which the heating contractor shall furnish to the mason, who will set them in place under the furnaceman's supervision.

The heating contractor shall work in harmony with the mason, and be responsible for the latter's work in connection with the furnace. There shall be provided for the furnace a wrought-iron hoe, poker, grate shaker, steel shovel, and evaporating pan, complete.

Smoke Pipe.—Connect the furnace with the smoke flue in the chimney, by means of a (No. 20 gauge) *galvanized-iron* smoke pipe, having a well fitted *lever* damper, with a T joint and a cold-air *check* damper.

Cold-Air Duct.—Provide and set in position, as shown on the cellar plan, a vertical cold-air duct, of proper dimensions, connecting at the foundation wall with the brick cold-air duct. This cold-air duct shall be made of (No. 20 gauge) *galvanized* iron and have a ($1\frac{1}{2}$ in. $\times 1\frac{1}{2}$ in. $\times \frac{1}{4}$ in.) *angle-iron* flange at the floor and against the wood frame in the wall opening. Insert a suitable *pivoted* damper and cover the wood frame on the outside with a *galvanized-iron* wire screen having a ($\frac{1}{4}$-inch) mesh.

Heater Pipes.—Run the cellar pipes and vertical stacks to the various registers as shown on the plans, each to have a damper placed near the furnace. The pipes in the cellar and the stacks from the cellar to the first-floor registers should be round; those for the second story, running through partitions, should be flat. All stacks and pipes running through partitions shall be double, with a ($\frac{1}{2}$-inch) air space between. All woodwork in partitions or in the neighborhood of heater pipes shall

be covered with IX bright tin, having lapped joints, turned around on the sides of the studs or other woodwork and well nailed thereto. The tin used for this purpose shall not be soldered. All plastered partitions over heater pipes shall be covered with *expanded metal* lath.

Pipe Covering.—Cover all pipes in the cellar with *two* layers of *sheet asbestos*, weighing not less than (10 pounds per 100 square feet), and paint on each pipe, in neat letters, with black paint, the name of the room to which it runs.

Registers.—All registers shall have suitable frames and IX *tin* boxes, and shall be well set, flush with the floor or the wall. The registers and frames in the floor shall be *black japanned*, and those in the walls, except parlor registers, shall be *bronzed*. The parlor registers shall be finished in *white porcelain enamel*.

Guarantee.—The contractor shall submit to the owner a written guarantee that the heating apparatus shall heat the rooms in the building as shown in the drawings to a temperature of (70°) F. in *zero* weather. In case, however, that *zero* weather may not occur within *one year* after the completion of the work, the contractor will be required to prove by scientific data that the system is capable of accomplishing the above requirements. Should any part of the system fail to fulfil the terms of this covenant, or any part prove defective within the time limit of the guarantee, he shall remedy all failure and defect, at his own expense, leaving the plant in good working order at the completion of the repairs.

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27. Under the subject of "Painting" should be included all the work pertaining to the surface finish of the exterior and interior of the building, whether confined to plain painting or inclusive of finishing, varnishing, and polishing of the hard-wood finish.

Glazing is sometimes included under this heading, though equally often it is included in the carpenter's work, especially when the glazing refers to sashes, etc., which are to be supplied by the carpenter.

PAINTING.

The painter shall provide his own scaffolding, ladders, and utensils, providing all materials of the best description, and the skilled labor required to perform his work in an acceptable and workmanlike manner.

Painted Work in General.—Cover all sap, knots, or other defects in the woodwork about to be painted, with a good coat of *shellac* before painting. See that all nails are set in, and after applying the priming coat, putty up all nail holes or cracks.

Exterior.—Paint all exterior woodwork, unless otherwise specified, including fences, clothes posts, etc., with *three* coats of paint composed of the best *American* white lead and pure linseed oil. The building shall be trimmed in *three* colors selected by the owner. Paint all exposed tin work, leaders, etc., on the building with *three* coats of *metallic* paint, ground in pure *boiled* linseed oil.

Shingle Staining.—All shingles to be placed on roofs or dormers shall be *dipped two-thirds* of their length in *creosote shingle* stain, of a tint approved by the architect or owner. The shingles shall then be stacked up and allowed to dry before being put on.

Treatment of Ironwork.—Paint all ironwork in the cellar, the *wrought-iron entrance* and *carriage* gates, and all other ironwork on the premises with a priming coat of pure *red oxide of lead* and *boiled* linseed oil. Finish with *two* coats of *white lead* and linseed oil paint, of such colors as may be approved.

Interior.—The *parlor* woodwork, including the *mantel* and the *picture* molding, shall be painted *white*, with *three* coats of pure *white lead* and linseed oil paint, each coat to be sandpapered before the next is applied. Finish with a coat of paint composed of *French zinc white* and *spirits of turpentine. Size* and *gild* the *pearl and bead* molding, etc., as directed.

All rooms in the second story and attic, except the second-story hall, shall be painted *three* coats of *white lead* and *linseed oil paint*, in *white* or *light tints* as approved by the owner. The *last* coat shall have a little *copal* varnish added and be *rubbed down* to a smooth, even surface.

All woodwork in the cellar shall be painted *two* coats of such colors as may be approved.

Natural Wood Finish.—All *hard wood* in the principal rooms, including the first and second story hall, stairs and mantels, shall be sandpapered smooth, removing all finger or other marks, and given a coat of mineral wood filler, which shall evenly fill the grain of the wood, and be wiped off while *wet.* Finish with *one* coat of pure *white shellac* and *two* coats of best *body varnish. Rub* between *each* coat, and *rub down* the last coat with pumice stone and *water.* Clean out all quirks of the moldings before applying the varnish.

The treads and risers of the stairs shall be *filled* and given *two* coats of the best *body varnish rubbed down* after *each* coat with pumice stone and *water;* and shall be finished with a coat of *oil* and *wiped*

off well. The *rear stairs* shall be finished in like manner. Finish all other woodwork in the first story, including the inside woodwork of *book cases* in the *library* and all closets in the building, with a coat of filler and *two* coats of *body varnish*. The *last* coat in *exposed places* shall be *rubbed* to a smooth, even surface. The tops of drip boards at sinks shall have a coat of filler and one of oil.

Floor Finish.—The floors of all principal rooms in the first story and the floors of hall and principal bedrooms in the second story shall be given a coat of mineral wood filler, *a coat* of *hard oil finish*, and a coat of best *floor wax*. *Sandpaper* after the *hard oil* has been applied, and rub the *floor wax* in well with special *weighted brushes*. Care must be taken that the floors be smooth and that paint or other spots be removed before applying the filler.

The remainder of the first and second story floors and the attic floor shall be filled and finished with a good coat of *hard oil*.

Wall Treatment.—The walls of all rooms and halls in the first story and *principal* bathroom shall receive a coat of *shellac size* and *three* coats of *paint*. The first *two* coats of *paint* shall be composed of pure *white lead* and linseed oil, the second to be *stippled*. Finish the walls with a coat of *zinc white*, ground in *spirits of turpentine*, tinted as approved by the owner and *stippled*. All rooms shall be finished in *two* tints.

Finish of Wood Ceilings.—Give the veranda, porte-cochère, and porch ceilings a coat of mineral wood filler, rubbed in well, and finish with *two* coats of best *spar varnish*.

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28. Under "Electrical Work" is usually included not only the wiring of the premises for electric lighting, but, also, the running of wires for electric bells and other means of communication between different parts of the house. Speaking tubes are also sometimes included under this head when their number is too small to warrant a special contract.

ELECTRICAL WORK.

All the electrical work herein included shall be executed according to the rules and regulations adopted by the National Board of Fire Underwriters, and subject to the inspection and approval of the local Board of Fire Underwriters. The contractor shall pay all charges for the inspection of the work, and, upon its completion, secure a satisfactory certificate of its acceptance. He shall also furnish guarantees pledging himself to maintain, at his own expense, the very best service,

and secure, likewise, at his own charge, for a period of *two* years, the efficiency of the system, and shall submit both to the architect.

System.—The building shall be thoroughly equipped, from the source of supply to each outlet, with *brass armored* insulated conduits, put up in such a manner as to provide continuous insulating channels for all wires, and the tubes to be so well connected as to exclude water and gas.

To the end that each and every wire may be at all times accessible for inspection or repairs, the location, junctions, elbows, position of switches, etc., and the final emergence of the tube beyond the surface at the fixture, must be effected, executed, and placed in accordance with the rules herein set forth, and the manner indicated on the drawings.

The sizes of the wires shall be determined on the basis of each lamp requiring (50) volts and (1) ampere. There shall be *one* group of risers for the building, the wiring on each floor to run from *one central point*, taking in all outlets. All tubes shall be of sufficient size to allow the wires to be readily drawn in or replaced at will; no tubes less than ($\frac{5}{16}$ inch) inside diameter shall be used; all tubes to be secured in place with metal clips, and no staples allowed unless absolutely necessary.

Where a number of elbows is unavoidable, an intersection box must be put in to facilitate the work of drawing in or replacing the wires. All tubes must emerge at outlets, in terminal boxes, leaving the outlets protected from plaster, etc. Place in position junction boxes from which all branches shall run, and use *standard* cut-outs; the boxes shall be formed by the carpenter, provided with hinged doors and lined with sheet asbestos. Protect each branch wire with a safety fuse.

All conduits and wires shall be concealed under the plastering or other finish. Blow *powdered soapstone* into the conduits, that the wires may be the more readily drawn in. All the principal rooms shall be wired in such a manner that the lighting may be controlled by a switch, located on the *side wall*, or elsewhere, as may be directed. All *hall*, *vestibule*, and *veranda* lights shall be controlled by *one* switch, placed at the *rear* of the *main* hall.

Place the most approved knife switch and cut-out box on the service wire at its entrance to the cellar. Insert a properly insulated tube in the wall for the reception of the main; this tube shall be graded to the inside of the building. A loop shall be left for the meter inside of the main switch. All annunciators or bell wires shall be placed within conduits and be readily accessible.

Bells.—Provide and set *two nickel-plated gong* bells, one for the *front door* and one for the *kitchen outside door*. The bells, connected with the electric system of the house, shall be placed in the *kitchen*, and left in good working order. The *carpenter* shall provide and set the push-button plates.

Annunciators.—Provide and place in the *kitchen* a neat annunciator box, made of *quartered oak*, the front hinged, and glazed with clear *plate* glass. This box shall have a (2½-inch) *nickel-plated gong* bell, and metal drops for each of the principal rooms in the first and second story. Extend wires from the annunciator box to the various rooms. Provide and set in place in each room a metal plate and push button to correspond with the hardware of the room.

Speaking Tubes.—Furnish and erect, with mouthpiece and whistle complete, (1-inch) tin speaking tubes from the *kitchen door*, *dining room*, *second-story hall*, the *owner's bedroom*, *principal bath-room*, and *cellar*, to the *kitchen*. The pipes shall be well fitted together and run as direct as possible.

All work throughout the premises shall be executed in a practical, skilful, and satisfactory manner, and every precaution taken to preserve the most complete insulation and secure the preservation of all tubing from moisture or injury. Everything must be left in good order for use.

BUILDING SUPERINTENDENCE.

INTRODUCTION.

1. Scope of Subject.—It is a difficult matter to formulate rules to be observed for the direction of building construction that would be applicable to all cases. Each problem of construction must be considered separately, and a system of inspection decided upon to suit each particular portion of the work. It is necessary, however, to lay down a fixed plan to follow in supervising the work, in order to give proper notice to the innumerable points in construction which require immediate attention. It is a fact well taught by experience, that work once finished is not always easily changed, and if ordered to be changed, or replaced by other work, will generally give rise to disputes and dissatisfaction, and often cause expensive alterations; all of which could have been obviated by attention at the right time to defects or mistakes. In many cases, the services of the architect include all the supervision considered essential for the structure, but in works of importance it is absolutely necessary to engage a *building superintendent*, who is well versed in building construction, to constantly supervise every detail of the work. The building superintendent is under the immediate direction of the architect, whom he represents, but his services, being special, are paid for by the owner. It will be assumed that a building superintendent has been engaged for the work, herein considered, who has undertaken the supervision of several buildings in the vicinity, and that his

entire time will not be devoted to the buildings under consideration. Under this arrangement, he will examine the work from time to time as it progresses, and inspect the materials as they are delivered on the premises.

The object of this section is to direct the attention of the superintendent to all the various details which should be observed, as well as to remind him of the defects to be looked for at each stage of the construction.

THE DUTIES OF A SUPERINTENDENT.

2. Drawings.—The superintendent should study the drawings and specifications well, in order to become as familiar with them as possible, and to form a thorough understanding of the projected buildings and surroundings, and the materials that will enter into their construction. He should not trust blindly to the accuracy of the drawings, for mistakes are liable to occur, no matter how accurately the drawings have been made, or how thoroughly they have been checked in the drafting room; he should check all measurements, and satisfy himself as to their accuracy, before allowing the work to be laid out or erected.

3. Inspection.—It is imperative that the superintendent should inspect all the work at each visit and not leave any part of it to be inspected at some future time; he should ascertain what each workman is doing, and should see that he is doing it properly, and when he visits the building the next time see that the work in progress on the occasion of his last visit has been properly done. By following up the work in this way it will be, comparatively speaking, an easy matter to detect any work poorly or improperly done.

The superintendent should endeavor to establish a standard by which each kind of work can be judged; that is, a uniform standard of practice in executing the work, so that the architect or the superintendent and the builder may better understand each other. The superintendent should not exact more than the contract and specifications call for.

It is good practice to examine and pass on all materials soon after they arrive at the building site, and if any are defective, to mark them and have them placed to one side, so that there can be no mistake as to what are rejected, or liability of their being used in the structure. The superintendent should see that the damaged or rejected materials are immediately removed from the premises, for, if allowed to remain for any length of time, some of them are likely to be smuggled into the work, unless the contractor is exceptionally conscientious.

4. Condemning Poor Work.—If the inspector is satisfied that a certain piece of cement work, for instance, contains poor material, or has been reworked, he should order its removal and not trust to the statements of the workmen, who, very often, rather than replace the work, will try to convince him that the material is as called for, and that the cement is freshly made. Another point frequently raised is when a particular brand of some material, such as cement, is called for in the specifications; the contractor, for reasons of his own, may say that the brand cannot be obtained in the local market; in order to get it, the work must be delayed; and, as a substitute, he offers another brand *just as good.* In such an instance it is well for the superintendent to know whether the brand specified can be easily obtained, and if not, satisfy himself that the brand offered as a substitute is as good as that specified. In framing the specifications, if the architect knows what materials can be obtained in the local market and prepares his specifications accordingly, no such question as that just presented will arise.

5. Adjustment of Disputes.—Nothing can be more embarrassing to the young superintendent than to have disputes arise as to the correct interpretation of the specifications between the owner and contractor, such as this: "Execute the work in a good substantial manner," etc. The superintendent in deciding the question—which, by virtue of his position as set forth in the terms of the

specifications and contract, he has a right to do—is liable to be too exacting in his demands for the execution of the work, in that way establishing a precedent, which he will have to maintain; and this stand, if he has to abandon it in any question which may arise later, is liable to place him in a position detrimental to his authority and perhaps his reputation. He is not likely to be too lenient in his exactions regarding such work, but rather the reverse, from an innate desire to make the work as nearly perfect as possible, as far as the specifications demand.

The superintendent should remember that he is working in the interest of the owner and under the direction of the architect, and should not be led into making any concession to the contractor that would be injurious to the owner's interest; at the same time, he should be perfectly just and reasonable in passing upon any of the work, or in deciding a disputed point.

It very often happens that the owner, when visiting the work while the building is in course of construction, happens to notice some particular part that is not in accordance with his preconceived idea, and he immediately assumes the right to notify the contractor that the work is not what it should be, or, in other words, not up to his expectations; the contractor will very naturally defend his work and himself, claiming that it is. Instead of doing this, the owner should have notified the architect, who is the proper authority to adjust matters between the two parties. His judgment and experience would soon convince the owner whether he was right or wrong. In such a case, whoever the decision sustains should abide by it, as it will be given according to general practice and local custom, and with a view of commanding the respect of both.

The foregoing remarks are intended to assist in the supervision of the work on and about the buildings treated of in this section, and are also applicable to other kinds of buildings. In the course of the subject, further remarks will be added in connection with any particular part of construction, if necessary, and in that way be better understood and remembered.

SUPERINTENDENCE OF THE WORK.

PRELIMINARY CONSIDERATIONS.

6. Site and Survey.—The problem of determining the site on which to locate the building is often a difficult one, as many things must be taken into consideration in order to make a good selection. This applies mainly to cases where the extent of the ground is not limited to small spaces, as is the case with city lots. The ground should be surveyed and staked out by a competent surveyor, and grade lines and levels established, that the general contour of the premises may be readily figured or mapped out. The location of the building on the lot should be determined as nearly as possible before the drawings are prepared, that the heights of walls, and basement windows, the number and size of exterior steps, etc., may be readily laid out and figured.

As, in the case under consideration, there is to be a number of terraces, roads, paths, etc., it would be advisable to place the work of grading lawns, planting shrubbery, etc. in the hands of a competent landscape architect, who would work in connection with, and subject to, the architect in charge. The work of the landscape architect is subject to the approval of the supervising architect, and the construction of masonry, terraces, steps, and other outside work on the premises should be supervised by the building superintendent.

The site for the building should be selected with the view, *first*, of obtaining good drainage; *second*, of placing the building in a position easily accessible from the entrances to the grounds, and, if possible, without the necessity of making tortuous ascents by means of planes or steps; *third*, to provide the most pleasing outlook for the principal rooms, and to place the building in such a position with regard to the points of the compass that the principal rooms may have good light at all hours of the day; *fourth*, the nature of the soil should be considered as to the possibility, during excavation, of encountering wet or marshy ground or an excess of

rock; such conditions should be kept in mind and obviated as much as possible, that unnecessary expense may be avoided. In latitudes between 38° and 48° north, the position described in *Architectural Design* would be the most desirable, for reasons therein stated.

7. Sounding and Excavation.—After the site for the building has been definitely determined, soundings should be made to form a basis of an estimate of the quantity of rock to be excavated. In a case of this kind, when soundings of a moderate depth only are to be made, a long steel crowbar and a heavy striking hammer are generally employed for the purpose, such as shown in Fig. 1. The bar should be driven at intervals of 10 feet each way and down to the depth required for the excavation, or until it strikes solid rock, as the case may be. If solid rock is found, the depth of each sounding below the surface grade should be noted in a field book, and, after all necessary soundings have been made, the amount of excavation, whether of earth or rock, may be determined from the established grade level of the proposed excavation, and the top of some designated stake or other mark. The expense of sounding, digging, test pits, or boring are generally charged under the head of surveying, and paid for separately by the owner, unless some arrangement is made to the contrary.

FIG. 1.

There are several methods by which the nature of the subsoil may be ascertained. A common way, and perhaps the best where boring appliances are not obtainable, consists in sinking trial pits to the depth required at various points. If, however, a very important or heavy structure is to be

erected, it is usual to bore the holes with an auger operated by hand, or by an artesian-well apparatus. It frequently is found that wet ground or free water exists below the top soil in elevated places, though no indication of it may appear on the surface of the ground. This is usually due to natural depressions in the surface of the rock or hard subsoil, as shown in Fig. 2. The existence of damp or wet soil a foot or two below the foundation of an ordinary building when the soil is firm over it is not a serious condition provided the cellar bottom is well concreted, and the foundation walls are built with a suitable *damp course.* If, however, wet clay overlays the rock, it is not advisable to build upon it, for soils of this nature are treacherous; the rock being also wet, the superimposed weight gives the clay a tendency to slide, the water on the rock acting as a lubricant.

FIG. 2.

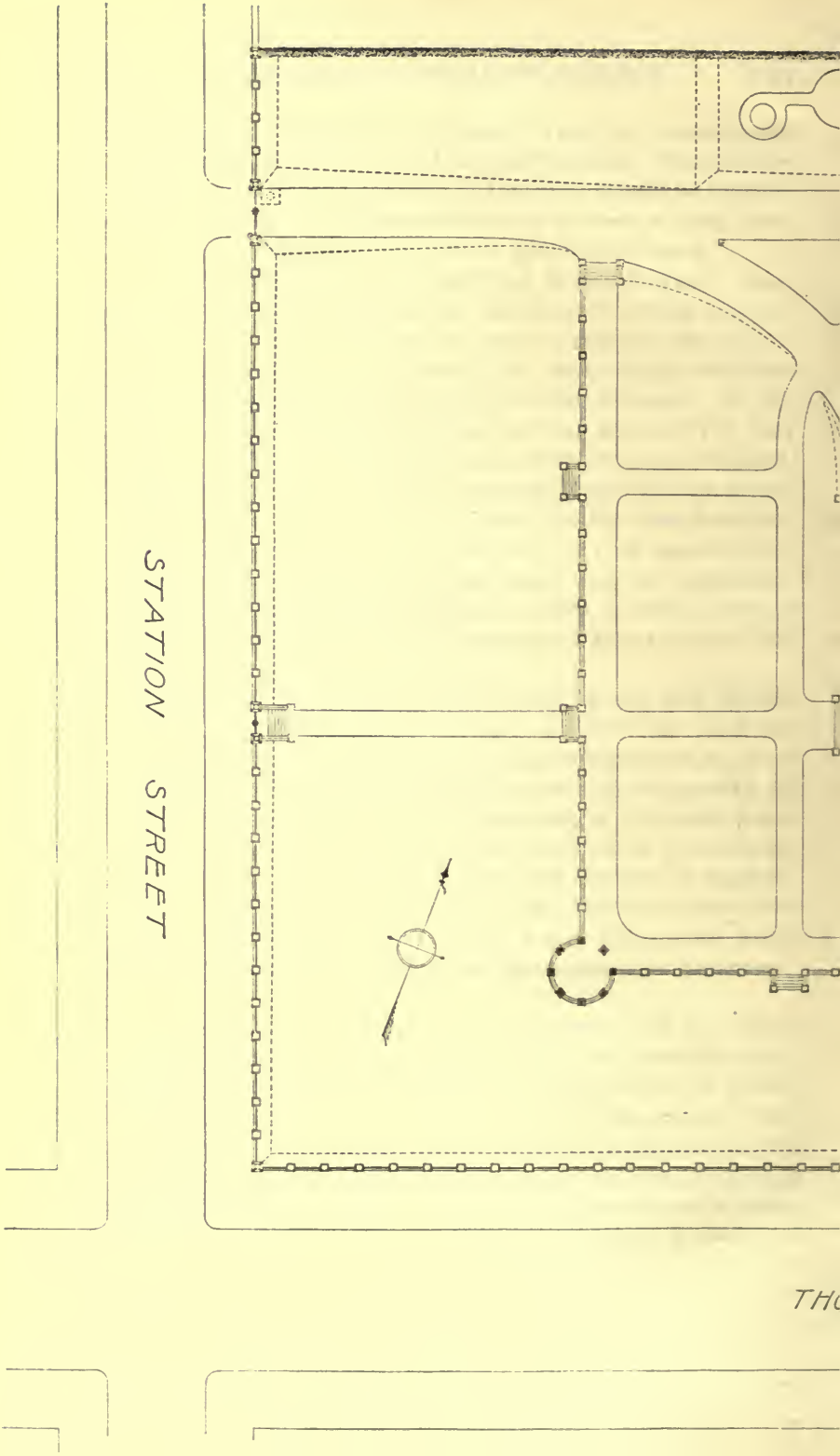
8. Cellar Excavation.—In excavating for a cellar on the slope of a hill, solid rock is often encountered, as the earth is thinner near the top of a slope of any extent, than it is at the base. In locating a building in such a position, it might be advisable to excavate some of the rock, in order to expose any crevices or open seams from which water might flow and collect in the cellar bottom. This would be likely to cause considerable damage to the foundation walls and cellar bottom, and by keeping the walls continually wet would render the house practically unfit for habitation from a sanitary point of view, and menace the stability of the foundations. If the water flows to any extent from these crevices,

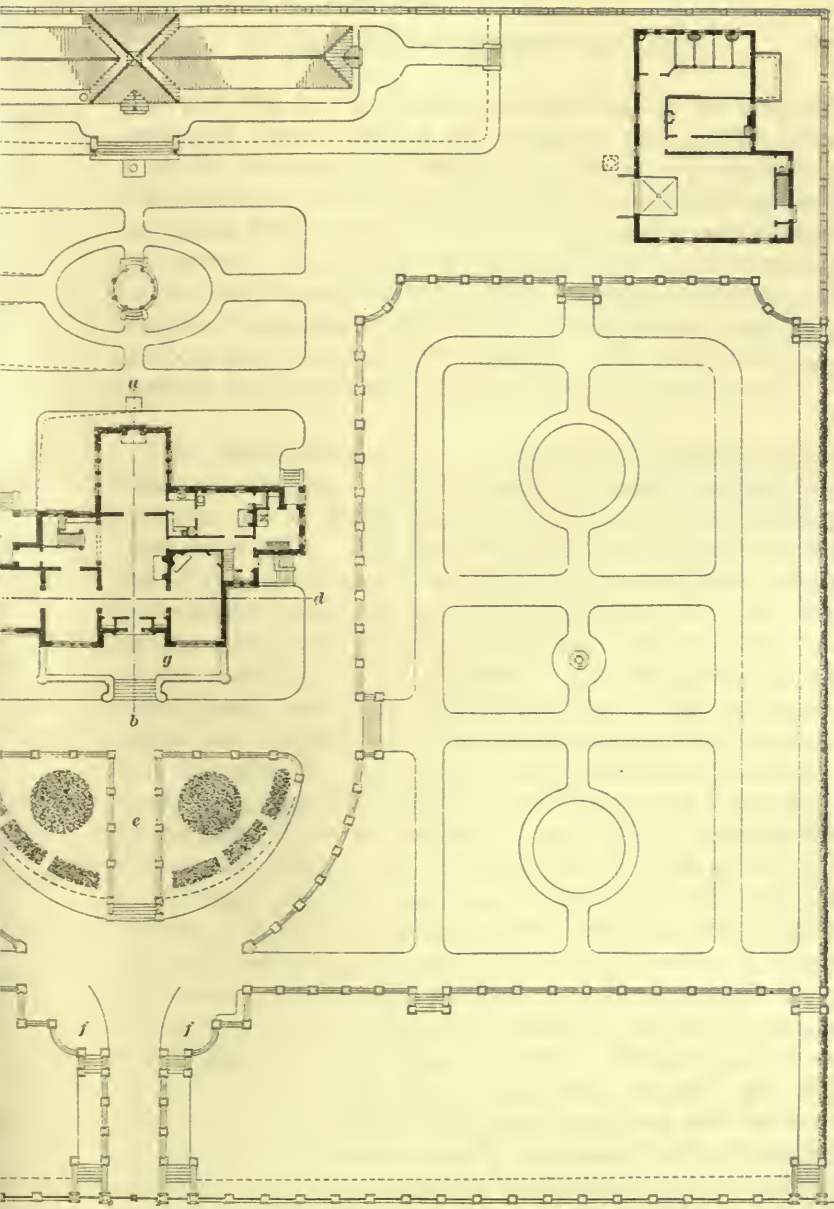
provision should be made to divert it from the masonry and give it a proper outfall away from the building. It is perhaps needless to say that a location of this kind should be avoided as far as possible, because cellars cut in rock in most cases are liable to dampness, for reasons previously stated.

If the conditions are such that rock is encountered a short distance below the surface, the necessity of cutting through it may very often be avoided by merely shelving the rock to secure a level bed for building the walls upon, and then grading up around the house and forming terraces. In this way the whole effect may be better than with all the rock excavated, the grade kept lower, and the terraces omitted. The cost of rock excavation is generally charged for extra, unless provision is made to include it in the specifications. The price per cubic yard to be paid for rock excavation is usually agreed upon between the owner and the contractor, and varies according to location, nature of rock, price of labor, etc., the quantity being measured in its natural bed before excavating.

Sometimes the architect does not call for any rock excavation in his specifications, preferring to leave that until the earth has been removed, when, if solid rock appears, he or an engineer can survey it, and, after ascertaining the amount, fix upon a price per cubic yard for excavating it, and make a separate contract for its removal. In some instances the changing of the site of the building but a few feet one way or another, or the changing of the level of the cellar bottom a few inches above that proposed, will insure a dry cellar and avoid considerable rock excavation, with its consequent expense.

9. The Lot.—The lot herein considered will be ground sloping gently from the main building in a southeasterly direction, towards Thoroughfare Avenue, and in a southwesterly direction towards Station Street; the ground on the other side of the main building is generally level and slightly undulating; all of which is to be graded to level planes, as required by the drawings. The lot comprises about 4 acres, with a frontage of 450 feet on Thoroughfare Avenue, as


STATION STREET
THO



GHFARE AVENUE

shown in Fig. 3. A terrace is formed back of the wall and along the street sides of the property, and graded down along the driveway and from the terrace, back to the lawns. The ground on the easterly side of the lot is slightly depressed and damp, which would indicate the presence of water below the surface. A system of porous-tile drains must therefore be provided to meet this emergency, the pipes to discharge in a main or trunk line, which in turn discharges into a large, dry cesspool near the front of the property. The front line of the building is approximately 160 feet from the avenue line.

10. The House.—The house has been designed with the object of exposing a large frontage towards Thoroughfare Avenue, and of giving a picturesque view of the building from every point. The first story contains a large entrance hall in the central part of the building, opening from which is the dining room; the stair hall is separated from the main hall by a large flat arch supported on columns; to the left of the main hall is the reception room and parlor, in the order named, and to the right is the library. All four apartments are connected with arched openings; from the main hall, immediately opposite the main stairway, a door opens to the rear hall, from which the kitchen, laundry, and servants' quarters may be reached; a large pantry connects the kitchen and dining room. The part of the building devoted to the main and rear stairs are carried up in the form of towers; a large veranda and porte cochère on the west, a plaza on the south, and entrances to the servants' quarters on the east and north sides, complete the plan of the first story.

The second story contains a spacious hall with a gallery overlooking the main flight of stairs. Through a door on the north the guest chamber is reached; on the right, and opening on the gallery, two large chambers are reached; through an archway on the right of the main hall and passing through the hallway, the owner's bedroom is reached; opposite the owner's bedroom are the principal bathroom, toilet room, housekeeper's closets, and linen closet; at the end of this hall and separated from it by a door is the rear stair

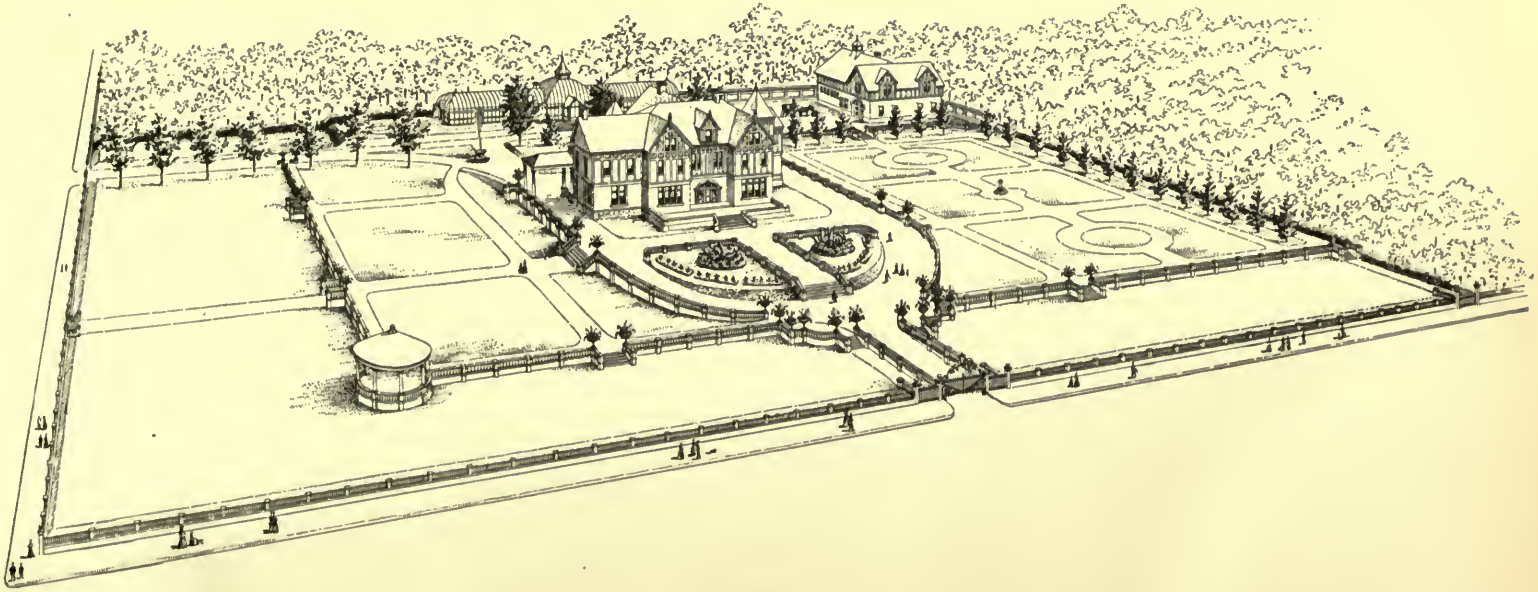


FIG. 4.

hall, from which the nursery and housekeeper's bedroom are reached. Between the owner's bedroom and the first chamber, opening on the gallery, are two large dressing rooms with a lavatory, clothes closet, and mirror in each. The guest chamber is provided with a dressing room, and that, as well as all other rooms, are provided with ample closet room.

The attic contains the bedrooms and a bathroom for servants, together with closet and storage room. The bedrooms, halls, and closets and the large storeroom are plaster-finished and trimmed. The remainder of the floor is left unfinished.

In the cellar a cold-storage, general storeroom, and wine room are provided, and are placed in a position accessible to the outside cellar entrance, as well as to the rear stairs.

The heating plant is centrally located, to afford as short and direct lines of service pipes to the various rooms and halls as possible. Ample room is provided for the storage of fuel, etc. The cellar has a concrete floor, the dumb-waiter shaft is built of brick in the cellar, and with a framed and plastered partition above this to the first story.

The exterior of the building is finished in open timber work, as shown in Fig. 4. The cellar walls above grade to the sill line are faced with *block-in-course ashlar* rough-pointed; the water-table is finished with $1\frac{1}{4}$-inch clean-cut wash, and the face rough-pointed. The walls of the first story are to be faced with squared random ashlar, fine-pointed, and jambs and reveals of window and door openings being *clean cut*. The second story and all gable and dormer fronts are finished in open timber work, forming panels which are afterwards plaster-finished. The roof is covered with red-cedar shingles laid 5 inches to the weather; the flashings, gutter lining, etc. are of copper; the chimneys above the roof line are faced with fine-pointed ashlar.

11. The Plaza, Etc.—The face walls of the plaza from grade to the coping are rough-pointed; the inside of the plaza wall is rough-pointed also; the plaza pavement is Portland cement pitched to a grade of $\frac{1}{4}$ inch per foot and false-jointed, to represent stone slabs.

All terrace foundation walls are of rubble to within 6 inches of grade level, rock-faced to coping under foot rail, and the copings, balusters, pedestals, etc. all clean cut; all terrace and entrance steps, and all platforms, are of stone in one piece, *fine-axed*. Flower pots, urns, pedestal and post caps are furnished in one piece, *all clean cut*. The north and east side walls are built of rubble to within 6 inches of the grade, and faced with random-coursed ashlar above grade. The front walls on Thoroughfare Avenue and Station Street are built of rubble below grade, and above grade are faced with rock-faced, random-coursed ashlar, backed with rubblework; the copings, etc. are to be clean-cut finished.

12. The Stable.—The stable, which is designed to conform to the style of the treatment of the exterior of the main building, has the following accommodations: The lower story contains a carriage room sufficient for the storage of four or five ordinary carriages; cut off from the carriage room on one side are four single stalls and one box stall. The stall partitions are 6 feet high, built of 2-inch matched Georgia pine, housed into posts and fitted into a cast-iron socket plate bolted to the brick wall, the partition being finished with a heavy Georgia pine cap and crowned with a wrought-iron stall guard. The posts are of oak 6 inches in diameter, and the floor of the stalls is of hard clay, and is drained into a covered cast-iron stall drain which discharges into the general drainage system. Each stall is provided with a cast-iron manger, wrought-iron bar hay rack, and a hitching ring. A manure vault is located at the rear of the stable, the walls of which are carried 4 feet below grade and 3 feet above, the bottom finished with concrete, and the vault covered with a heavy frame and a hatchway door. A small, tight-fitting door near the floor of the stable is provided for access to the vault. Between the carriage house and stalls is a harness room, tool room, and stair hall, all plaster-finished. The upper floor of the stable provides three sleeping rooms, a bathroom, and a toilet room, all

lathed and plastered, as well as storage room for hay and feed. The inside walls of the carriage room are faced with white enameled brick, with a white-marble base 9 inches high. The ceiling is divided into panels with false beams and finished in white oak. There is no cellar under the stable. Girders resting on piers support the $3'' \times 12''$ Georgia-pine floor joists, spaced 12 inches on centers, over which is laid $2'' \times 2''$ tongued-and-grooved clear Georgia-pine flooring, blind-nailed to every joist, and top-nailed at all butt joints. Auger holes $\frac{3}{8}$ inch deep are bored for the top nailing, and after the nails have been driven, the holes are filled with wood plugs. The joints are calked with oakum and filled with hot tar.

13. The Greenhouse.—The greenhouse is built upon a continuous foundation wall, which is started 4 feet below grade and carried 12 inches above grade. A stone water-table 12 inches high is built in the wall all around the building. Under the central pavilion the earth is excavated to provide 8-foot headroom, and the cellar bottom is finished with concrete; space is provided for a hot-water heater and for fuel; the remainder of the cellar is devoted to storage room for herbs and roots, flower pots, etc., and a potting table. The floor in the central pavilion is of concrete, supported on brick arches and steel I beams; this part of the building is devoted to the larger plants and shut off by a glazed-sash partition from the other parts of the building. The floor in both wings is of natural earth, and slat-floor walks, in portable sections, are placed along the aisles. The greenhouse is built upon a plane, elevated about 3 feet above the north driveway, and a broad flight of steps is built immediately in front of the central pavilion, which adds very materially to the general appearance of the greenhouse. The work on this building will be inspected for the purpose of detecting faulty construction only, as the plans and details of it are assumed to have been approved by the architect and owner.

Other structures on the premises, such as the summer

house, fountain, wrought-iron gates, etc., will be explained in detail at the proper time.

14. The Specifications.—The specifications are drawn up as follows: (1) A general mason's specification covering all the excavations except that included under the contract for greenhouse work, and the grading. The mason, as principal contractor, will sign the contract covering the entire work, except the greenhouse and other special work, and shall be held responsible for the due performance of all the carpenter work, plumbing work, and work of other subcontractors on the premises. (2) The grading, filling, earth terracing, road and path building, sodding, and setting of trees and shrubs are made the subject of a special specification, and the work executed under the immediate supervision of the landscape architect, who will superintend this part of the work, subject to the direction of the supervising architect. (3) A general specification covering the entire carpenter and joiner work in and about the premises, with the exception of that in the greenhouse. (4) A general specification for each of the other trades, covering all labor and materials required, and to be furnished on or about the premises.

The horticultural contractors will furnish the specifications covering the work to be done on the greenhouse, etc., which, after the architect has approved it, will be regarded as the official specifications for this work.

15. Scale and Detail Drawings.—Scale drawings for all work, and detail drawings of important parts of the work, will be furnished; or any special information tending to facilitate the execution of the work will be given by the architect in charge.

The architect should endeavor to have all matter pertaining to the work, and the different features that are indicated on the drawings and called for in the specifications, fully explained to the owner, when the latter is a person inexperienced in building construction, taking particular note of his preferences regarding all features of the work. A little

patience on the part of the architect at this time in fully explaining his work to the owner, and on the part of the owner in studying the plans and specifications, may save a great deal of subsequent trouble and annoyance and avoid the possibility of altering work to suit the owner's taste after it has been finished.

16. The Contractor.—Much may be said and many theories advanced in favor of making one contractor solely responsible for the work, or in dividing the work up among two or more of the trades and in that way dividing the responsibility and increasing the cares of the owner and architect. It is a well known fact that work divided up among a number of men on the same job, although generally productive of well executed work, is seldom completed without serious debates arising as to who should do certain pieces of work, and when the work is done wrong who is the guilty party; in fine, one will shift the responsibility to another in the effort to save himself. Perhaps the best plan is that of giving the work to one man, making him directly responsible to the owner for every part of the work and for all subcontractors and artisans under his charge. In the event of mistakes, bad work, or the like occurring, there is then but one man to look to for their correction, or for the replacing of work improperly done that has been condemned by the architect.

The owner has had the ground surveyed and staked out, the architect furnishing the engineer with necessary information as to the location of the building, terraces, etc. The more important grade levels established, and the various points and levels indicated on the survey, are marked by *red stakes.*

The contract has been made with one man for the execution of all work in and about the premises, as called for or shown, with the exception of (1) the greenhouse, which is let under a separate contract; (2) the heating apparatus selected by the architect, which will be built under another contract; (3) the sodding, tree and shrub planting, etc., which has been let under still another contract.

There are thus four contractors, each working independently of the others; but in all the specifications there appears a clause which stipulates that they shall work in harmony with one another and shall not in any way hinder or retard the progress of the work. Any question of right or authority, or disagreement of any kind pertaining to the work and which is likely to impede its proper execution, shall be referred to the architect for adjustment or decision, which shall be final and binding on all parties concerned. The work of the minor contractors shall not be considered at present, but will be discussed in the proper form when that stage of the work is reached.

17. Clerk of Works.—A clerk of works is a person employed by the architect and paid by the owner, and, although paid by the owner, he is subject to, and responsible for the execution of the work under his immediate care, in strict accordance with the drawings and specifications and such written or verbal instructions as he may receive from the architect during the progress of the work. He should be paid a good salary, to raise him above the many temptations that are liable to beset him. He should be strictly honest and watchful in the performance of his duties, and should possess a knowledge of building operations, materials, market prices, etc., and should be able to read plans or other drawings submitted to him, and to make sketches of any detail of the work as occasion demands; he should understand the measuring and valuing of executed work. He should take charge of all drawings on the works, and if loaned to the workmen or others on the premises, see that they are returned to him at the close of the day's work. The contractor should always lay out his work, take all necessary measurements, and order all materials, and the clerk of works should never place himself in a compromising position by ordering any material, or by furnishing measurements, thus placing himself in the position of contractor's agent, in that way jeopardizing the owner's interest. The clerk of works should keep a daily record of the progress of the work, the materials

delivered, their quality, etc., and any order to alter work or valuation made of any work, the number and trades of the workmen engaged on the premises, submitting a weekly or monthly report to the architect, setting forth the items just enumerated and calling for additional drawings or advice, and making such remarks as the circumstances warrant.

The clerk of works should give particular attention to extra work, to see that all is properly done, taking measurements of the work, if necessary, and keeping an itemized account of everything pertaining to such work, as well as any work altered or omitted, so that when the time arrives for the settlement of the account, his notes may be produced, avoiding any chance for dispute or difference of opinion as to the value or amount of the work executed.

The clerk of works should never attempt to reach subcontractors except through the principal contractor. Should the work of a subcontractor be done in such a manner as to justify condemning it, the clerk of works should notify the contractor to alter it; if the notice is not complied with within a reasonable time, the principal contractor should be served with a *written* notice without delay, and, if he should refuse or neglect to make the change within a specified time (generally about three days), the architect should be notified and full information given him on the case. Should it be required to make any alterations in the work, or to press forward the execution of some particular part of the work, a letter sent to the principal contractor is generally sufficient. The clerk of works should avoid all disputes in regard to the work, and in deciding a disputed point he should make sure that he fully understands the situation. After giving his decision he should maintain his position in the matter; in fact, he should establish his authority at the beginning, and once established, it is a comparatively easy matter to maintain it throughout the work.

18. Report of Work.—The following form of report will meet all requirements under ordinary circumstances:

No.....

To Mr. John M. Smith, Architect, No. 25 Exchange St., Boston, Mass.

Report of work in progress at No.....Street or Avenue, for.....from.....to.....1898.

Workmen Employed. No.	Trade.	Number of Days.						Value of Work Since Last Report.			
	Masons										
	Stone Cutters										
	Stone Carriers										
	Bricklayers										
	Terra-Cotta Hands										
	Plasterers										
	Plumbers										
	Gas-Fitters										
	Steam Fitters										
	Slaters										
	Tile Setters										
	Carpenters										
	Joiners										
	Wood Carvers										
	Painters and Decorators										
	Electricians										
	Bell Hangers										
	Glaziers										
	Engineers										
	Blacksmiths										
	Tin and Copper Smiths										
	Iron Setters										
	Riggers										
	Apprentices										
	Watchmen										
	Excavators										
	Miscellaneous Laborers										
	Value of work previously executed										
	Total										
	Value of materials on the ground										

Weather.

From..... to.....

Monday.....

Tuesday.....

Wednesday.

Thursday...

Friday.....

Saturday...

Sunday.....

Drawings Received.	Drawings Required.

Remarks.

.....

.....

.....

.....

.....

PRACTICAL WORK.

FIRST VISIT.

19. The **principal contractor** is furnished with a copy of the survey and a full set of drawings and specifications covering the work under his charge, and an appointment is made with him to meet the superintendent on the ground for the purpose of staking out the building and establishing lines

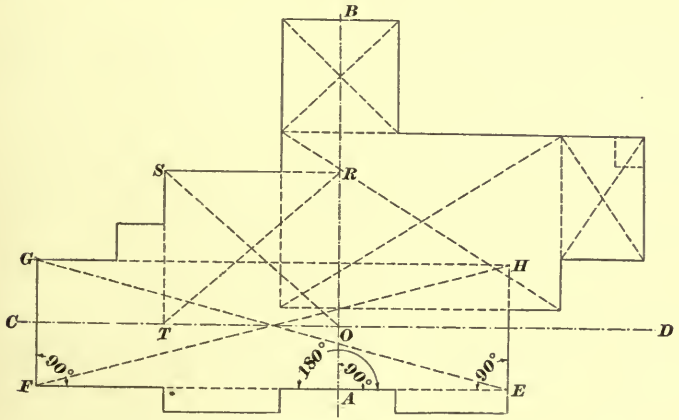


FIG. 5.

and levels. On the appointed day the contractor and superintendent meet on the ground. The contractor has brought a carpenter along, and also several pieces of studding pointed at one end, a number of rough pine boards, a bundle of stakes, a hatchet and a plumb-bob; the superintendent has brought a 100-foot steel tape, which should be divided into feet and inches (not feet and tenths), a builder's level or a transit with which to turn the angles for the building, and a field book. From the foregoing list of accessories it might appear that many of these things were not necessary; but as the work is laid out, the part each is to play will be readily seen. In setting out a small country cottage, a number of these things might be dispensed with. Where an architect's or builder's level cannot be had, a very simple method, for

ordinary work with simple outlines, is to take a long straightedge and a carpenter's spirit level; then fix one end of the straightedge on the stake and place the level on the top of the straightedge; after being adjusted, in each case, simply sight the bottom of the straightedge to each corner. Square the rectangle by making the diagonals equal, as shown in Fig. 5. The level of the foundation wall or sill, as well as the position of each corner of the building, can then be very readily determined.

20. A Simple Rule.—A building of moderate proportions may be squared by what is commonly known as the *3, 4, 5 rule*, which is applied in this way: At one corner of the proposed building set a mason's square, such as shown in Fig. 6, and stretch a line each way from the corner and coinciding as nearly as possible with the side of the square; then on one line measure off 3 feet, on the other line measure off 4 feet, and then adjust the two points so measured, until the distance between them will measure exactly 5 feet, as shown in Fig. 6. The size of the triangle may be increased by multiplying these dimensions by a common multiplier, which can be checked by the measurement of diagonals, or otherwise, after all the corners of the building have been fixed. The accuracy of the angles laid out in this manner may be checked by the rule (*The square of the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides*).

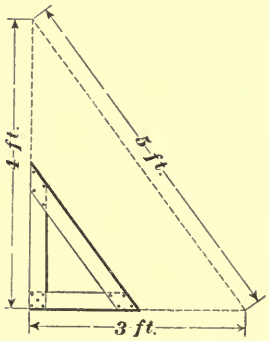


FIG. 6.

The survey of the property gives the lines and levels and locates the axial lines *A B* and *C D*; see Fig. 5. The axial line *A B* is perpendicular to the avenue front and 250 feet from the Station Street property line. The axial line *C D* is parallel to the avenue front, 179 feet from it, and crosses the line *A B* at right angles. According to the survey, the

top of stake A is on the neat or ashlar line of the building, and is figured as being 10 feet from the axial line $C D$. It is also on the axial line through the center of the main hall, 3 feet 8 inches below the level decided upon for the top of the stone foundation wall, or 1 inch above the lowest line of the water-table course. Stake A is therefore the point from which the building will be laid out. Setting the level over stake A, and plumbing it until the point of the suspended plumb-bob is directly over the tack in the stake, the telescope of the level is adjusted until the vertical cross-hair corresponds with a plumb-line or target pole held over stake B, this then is the axial line $A B$. The telescope is then revolved horizontally through an arc of 90° around towards point E on the right, and measuring with the tape the distance $A E$, a stake is there driven and a tack in the top marks the exact distance. To maintain the tape in a level position, it should also be held taut, and a plumb-line used to locate the exact point to which the measurement is taken. This will be one point on the front main line of the building; the telescope is now turned a full half circle, or 180°, and the point F is marked by a stake and a tack, in a manner similar to that at point E. The line $E F$ then is the neat front line of the building. By setting the level over the points F and E, respectively, and turning an angle of 90° at each point as shown, then measuring the distance $F G$ and $E H$ and placing a stake at each corner, the first rectangle on the site will be completed. To check the accuracy of the measurements taken, and of the position of the stakes, measure the diagonals $F H$ and $G E$, and if they are found to be of the same length, the corners will be right angles, and will form a perfect rectangle. The same method may be followed until all the points have been obtained, laying out the smaller rectangles by measurement of the diagonals, if so desired. By measuring from the point of intersection of the axial lines the distance $O R$ equal to $T S$, which may be obtained from the plan, and the distance $O T$ equal to $S R$, setting the level at these points and turning an angle of 90° at each point, the point of intersection of these two lines

at S will be a corner of the building. Thus, by working from the axial lines AB and CD in the manner just presented, the remaining angles of the building may be readily set out.

The arched openings between the parlor, reception room, hall, and library are respectively centered on the axial line CD.

The batter boards, which were built of the rough boards and secured to the pointed pieces of studs acting as stakes, having been set up in position and marked with the neat line of the building all around, nothing remains to be done but to mark off on each board the outside and inside footing lines and the inside line of the foundation wall, making the marks permanent by means of V-shaped cuts, as shown in Fig. 7, which also shows the batter boards in position at the corner of a building, with the notches cut and the lines strung. The position of the footings and wall in the excavation is determined by plumbing down from the lines stretched between batter boards.

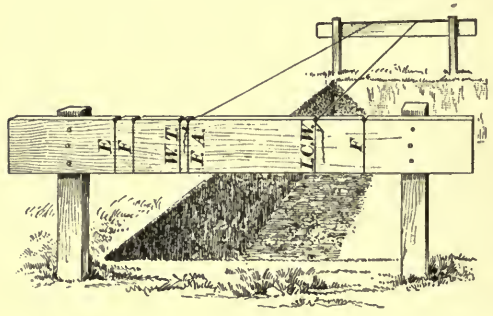


FIG. 7.

21. Levels.—At least one of the batter boards should be placed so that its top edge is on the level determined upon for the top of the foundation wall, water-table, or some other important level. It will, however, be found of great advantage to have all the batter boards set to some uniform level, such as that of the top of the foundation wall (if such a thing is possible), as the masons in leveling up the last course of stone can then bring the walls to a uniform height without the extra labor of leveling all from one bench mark, or calculating the height from some other fixed level. It

might be well to mention here that the supports for batter boards or bench marks should be well driven into the earth to guard against possible shifting of the lines through dislodgment of the stakes. After the batter boards and bench marks are all set in position, a line is cut with the spade all around the building at a distance of, say, 12 inches beyond the ashlar lines. The temporary stakes marking the angles of the building may be removed, as lines strung between the batter boards from the notches on the ashlar lines crossing each other at the corners will mark the angles. The lines and levels for the stable, as well as those for the terraces, street walls, etc., may be laid out in a manner similar to that adopted for the laying out of the main building.

Staking out the buildings is the duty of the contractor, unless the building is of sufficient importance to warrant the employment of an engineer for the purpose. The architect or his superintendent merely verifies the correctness of the work as laid out by the contractor, and gives him all necessary assistance, but in no way assumes any responsibility therefor. The earth will be excavated to the rough line marked by the spade cuts. The object of excavating beyond the wall line is for the purpose of allowing room to build the wall to a line on the exterior, pointing up the joints, and allowing space for gravel or other special filling, if such is required.

22. Commencement of Work.—When it is found that the natural sod is good and suitable for future use in sodding after the grading is done, the laborers should be instructed to cut the sod from the building site in long strips about 10 inches in width and in lengths of from 4 to 6 feet, and to roll them up. The sods should be placed on the north side between the site for the greenhouse and the street. The top soil, loam, and gravel should then be placed in separate "spoil banks," or heaps, away from the building and at a point to be convenient when required for grading or road building. The excavated material should not be nearer the

edge of the excavation than 6 feet, to allow for the erection of staging and space for mortar troughs and supplying the masons with materials. It is very important that the excavated materials be deposited at a point which will be as convenient as possible when they are wanted again. It is a common occurrence to find the earth heaped up to a considerable height without any regard to the position of the porch piers and trenches, and when the time comes to excavate for the piers, etc., it is necessary to dig clear through this pile as well as into the undisturbed earth, necessitating an extra expense which by a little forethought could be avoided. Handling any material two or three times adds a considerable amount to the labor and expense, as well as tending to reduce the net profit of the contractor. It is important also that the different soils should be piled up separately. The large stretch of nearly level ground along the west side of the property is suitable for piling of lumber and framing. The north end of the property immediately at the rear of the main building is suitable for the piling of stone and brick—one end being reserved for stone dressing and the other for mortar mixing. In fine, all materials should be deposited on the ground in a position easily accessible and arranged to avoid rehandling.

It is presumed that all the necessary preliminaries have been arranged, and nothing now remains to be done but the actual work of excavation and the delivering of materials on the ground. The contractor promises to deliver on the ground all necessary scaffolding, implements, etc. without delay, and the work of excavation is to commence immediately.

It should not be inferred that the first visit, second visit, and so on, made at intervals of several days, would be sufficient for an undertaking of the magnitude presented in this section, as a work of that kind would require constant or daily attendance on the part of the architect or superintendent, and a clerk of works, with an office established on the premises, would be a necessity. For ordinary buildings it is usual for the superintendent to visit the works once or twice

a week, depending upon the importance of the work and the amount of supervision required and paid for by the owner; for instance, in the building of a small country house, it would not be reasonable to expect an architect or his superintendent to visit the work every day, as the commissions received for the work would not warrant it.

SECOND VISIT.

23. Allowing the contractor one week or ten days to have all necessary implements, etc. on the ground, and to get the excavation for the main building nearly done, the superintendent should visit the premises for the second time and find a large force of laborers is at work, and the excavation for the main building nearly done. Looking around, the superintendent should see that the sods, top soil, loam, and gravel have been placed in separate heaps in the proper places. One great pile of rough quarry stone, another pile of ashlar, and a third pile from the appearance of which should contain some three thousand brick; a large quantity of rough plank, sand, lime, cement, and other material should also be found on the ground. Carpenters should be busily engaged erecting a shed at the rear of the main building for the storage of the lime, cement, etc. The superintendent should now examine the sand, taking a handful at random, rub it between his hands, and find if it pricks the skin and has a sharp crackling sound; he should then wet a handful, which, after it is compressed in the hand, should not cake or cling together, thus indicating that it contains very little loam, or is, in a word, *clean*. The superintendent should also notice that it does not discolor the hand, which is another test for the presence of loam. This sand being clean and sharp will require less cement than if it were finer or contained a greater amount of loam or other inferior substances. The coarser grades of sand are preferable to other kinds, and that obtained from quartz sand pits is undoubtedly the best. This sand, if used for plastering and being unusually clean and coarse, will very often require the

addition of a little finer sand or loam, especially when no hair is used for the mortar. The sand should be screened to remove the coarser gravel, which is deposited in one end of the cellar for future use in preparing concrete and for filling trenches, etc.

24. Testing Cement.—Many methods are resorted to in order to determine the best properties of cements, their resistance to the action of the atmosphere, water, etc., and their compressive and breaking strength. There is a wide diversity of opinion as to the best methods of testing cement, and this question has been under discussion for many years, the results being given in a number of works on masonry and construction. In engineering work of magnitude, such as masonry bridges, abutments, retaining walls, drains, etc., very rigid specifications are drafted covering the tests for this particular material, and a time test varying from a week to a month or more is insisted upon—the contractor being required to have the cement delivered on the ground a sufficient length of time to permit of the tests being made, previous to that fixed for the laying of foundations. The manufacturers of cement very often publish tables compiled by some eminent engineer, setting forth the properties of their material, which may be accepted or not; engineers, however, generally prefer to make their own tests. In work where a great deal depends on the construction and bonding of the walls, rather than on the strength of the cement, a slight variation will be of no consequence, provided the cement is of some recognized brand that has withstood the test of market competition.

25. Results Obtained From Tests.—It would hardly be necessary to dwell on the various methods employed by engineers in testing cement, as an explanation of these may be found in the reports of The American Society of Civil Engineers, and in a number of standard works on building construction as well. The superintendent should know, however, how to test the cement at the work in as short a

space of time as possible. It very often happens that he finds the cement on the ground one day while the actual work of wall construction is to commence the next or even the same day. If, on looking over the ground, he finds in making his tour that a large quantity of cement has been delivered, and that there are four brands of it, representing the product of as many manufacturers, the cement should then be passed upon, and should there be any brand on the ground not called for in the specifications, or a brand the quality of which the superintendent is in doubt about, he should test it. In a case of this kind the following simple test might be applied: Mix a stiff mortar in the proportion of 1 part cement to 1 of sand of each kind of cement furnished, and form of each kind two "briquets," or cakes, from 2 to 3 inches in diameter and $\frac{1}{2}$ inch thick, and spread them out on a board exposed to the sun for about an hour, or until they become firm enough to handle, after which take one sample of each and immerse in water for about two hours. Care should be taken to mark each sample, that the different varieties may be easily distinguished. After this time has elapsed, the superintendent should examine the samples. Suppose that he finds sample No. 1 had become quite hard in the air and resisted the tensile strain exerted by pulling it apart with the hands before breaking, and the fracture was then clean with sharp edges, it proves the sample of cement No. 1 sets well in the air and under water, and for this reason it is suitable for masonry below grade. He then finds that sample No. 2 left in the air has become very hard, in fact harder than No. 1, but he also finds that sample No. 2 in the water has crumbled into a heap, indicating that though the action of this cement in the air was very encouraging, it is entirely unsuitable for use in positions where the mortar is to be depended upon to resist water. Sample No. 3, air set, is soft and crumbles at the edges, it breaks very easily, and upon being pulled apart, it breaks in small pieces. This sample in water is no better, showing that it is a slow-setting cement, and though in time it might attain a hardness equal to the other, it is not desi-

rable for the work. Sample No. 4, air set, and the others in the water, are both very hard and resist the breaking tests very well. The No. 4 sample, being Portland cement, to be used in pointing, etc., is accepted at once. The Vicat cement which is specified, and which will be used for the setting of ashlar, etc., having qualities peculiar to itself which renders it valuable for use in setting limestone, etc., is accepted.

26. Judging the Quality of Cement.—A few cement barrels are broken open, and in one or two instances the cement is found to have partly set or caked around the edges. In this instance the superintendent should order the barrels removed, or caution the contractor to use none but the free cement. It very often happens that the cement becomes hard around the edge of the barrel and should not be used, although the balance of the cement in the barrel is in good condition.

The superintendent should not be induced to accept cement on the recommendation of the masons or contractor, nor accept their tests, which very often are worthless. Masons have been known to declare that cement when placed on the tongue should have a biting taste, the intensity of the bite indicating the strength of it; then, again, many say that it should be of a certain yellowish tinge and have a soft greasy feeling when allowed to run through the fingers, and so on. Such tests are useless, and are offered through ignorance or with the idea of deceiving the superintendent. The color of cement varies, according to the grinding and the locality of the quarry from which the stone is taken, from a light to a dark gray, very often having a greenish or bluish tinge. The dry cement should be uniform in color and entirely free from streaks, which indicate impurities or imperfect grinding.

27. Limes.—Limes may be said to be either common or hydraulic, according to the amount of silica, alumina, etc. they contain. The best common limes, frequently termed

fat, or rich, limes, are manufactured from limestone and marble that contain less than 5 or 6 per cent. of impurities. After calcination, the lime is broken up and put on the market in lump form to prevent *air slaking*. Fat limes slake quickly when immersed in water or when exposed to the air, and harden slowly in the air and not at all in water. Lime becomes hydraulic when it contains 15 per cent. or more of silica and alumina; it slakes slowly and quietly, and hardens under water, hence is adapted for use in damp situations. Lime having a percentage of silica, alumina, etc., varying from 6 to 15 per cent., is poor, and does not augment in bulk to any great extent when slaked with water. Ground lime contains a large percentage of silicates, approaching the nature of cement, and will not slake when mixed with water, but will set rapidly in air or water.

28. Inspection of Lime.—On the occasion of the superintendent's second visit, after completing his tests of cement for the time being, he should proceed to test the lime to be used in the mortar for brickwork. He should observe that there are several brands of lime on the premises, and in glancing over the barrels may discover that two or three of them have burst open, and the lime, as far as can be seen, is in powder; the barrels are opened, and, on examination, it is found that the lime has for the most part crumbled, indicating that it has become *air slaked*. A few lumps, taken at random, are immersed in water and do not slake immediately; the barrels from which these are taken are then ordered from the premises as being *unfit for use*, although the lime may have been of excellent quality when the barrels were filled. A sound barrel is next broken open and a few lumps of the lime are immersed in water; two or three of the lumps begin to slake immediately, but the others remain inert for some time and then slake slowly, leaving a hard center or core, indicating that these lumps are *underburnt*, which, if allowed to be mixed in the mortar, would continue to slake slowly and swell, thereby causing the mortar to crack. This lime then is *entirely*

unfit for use, and should be condemned and ordered off the ground.

Overburnt lime is even worse than underburnt, for the lumps, being hard, resist the action of the water and do not slake readily; the slaking process commencing slowly and a great deal of time being consumed in the process. *Any lime, then, that is overburnt should be rejected.*

On opening a barrel of first-class lime and immersing several lumps in water, it is seen that the slaking process commences almost immediately; the action, due to the oxygen of the water combining with the lime in slaking, gives forth a hissing sound, and a warm white vapor arises. This lime, then, is satisfactory, and may be used with an admixture of cement in making mortar for brick walls in the cellar or such places where dampness is liable to occur.

29. Hydraulic Properties of Lime.—The hydraulic properties of some particular brand of lime may be unknown, and if it is desired to ascertain whether it is suitable for use in damp situations or under water, a test should be made. The following test, though very simple, should be sufficient under ordinary circumstances: A stiff mortar mixed in the proportion of 1 part lime paste to 2 parts clean, sharp sand, thoroughly incorporated by continual working until all streaks disappear, should be formed into a cake, as was done with the cement, and immersed in water. After at least 24 hours, if the cake has hardened perceptibly, it may be reasonably inferred that the lime is hydraulic.

30. Excavation.—Nearly all soils in a vertical bank, except dry sand, will retain their shapes unless disturbed or acted upon by frost or moisture. The earth, acted upon in this way, assumes its angle of repose, which varies according to the nature of the soil itself—usually about 30°. In excavating earth to any great depth, when the excavations are to be left open for a long time, the bank should be held in place by means of sheet piling, or the sides of the excavation should be dressed down to a slope of at least 60°.

Ordinary clay or kaolin strata in an embankment are a constant menace, as they are liable to act as a lubricant. Under such conditions the bank is likely to slide in, thereby causing a great deal of unnecessary work, unless provision is made to avert it. In the case under consideration the earth in the excavation is assumed to be a firm loam with strata of coarse gravel; a finer and harder stratum appears lower down, which gradually merges into a clayey nature at the bottom of the excavation. At the southwest corner the soil is found to be quite wet, which indicates the existence of a spring or a rock depression in the immediate neighborhood. This ground looks treacherous to build upon, especially on account of the wet clay; for this reason it will be necessary to dig trenches down to solid rock, which is found at a distance averaging about 2 feet below the line of the finished cellar bottom. The soil changes gradually from hard, coarse sand to a light-colored clay in the rock depression, which is quite wet. On excavating to clear the rock, we find a small stream of water flowing from a crevice in a southwesterly direction, which indicates that it probably comes from a spring or the high ground adjoining. It will be necessary in this case to divert the flow of water, that the foundation wall may be kept dry, and to do this it will be essential to excavate a pit in the rock, 2 or 3 feet outside the foundation wall, and sink it at least 2 feet below the level of the cellar bottom. The foundation walls may then be carried down to solid rock, but laid dry with large, sound, flat stones to the level of the adjacent footings, and laid up from there in mortar.

31. Trenches.—Trenches are now cut in the rock from the bottom of the wall trench, at different points, to the pit just mentioned, and filled in with broken stone and covered with a layer of straw. The pit is drained through a close drain of 6-inch vitrified earthen pipe laid with a good grade, and the joints made tight with cement mortar. The extension of this drain forms the trunk, or main, for the discharge of the subsoil drain pipes laid under the terrace on the west

side of the premises, all of which will be subsequently considered. In this way the water may be diverted to the pit, and should the flow of water increase in volume, as it is likely to do in the spring, the outlet drain pipe will carry it to the blind cesspool. But should any water remain in the trenches, the cellar may still be dry, as the substructure of the wall, being laid up without mortar, will allow the water to flow in and around the stones, without causing any damage to the work or soaking the cellar floor or walls.

Now, as the specifications do not require the contractor to carry the walls down below the level of the footing course, nor to cut the pit and drains in the rock, and not being called for or included in the contract, the owner will be required to pay him *extra* for this work. It is then agreed to pay the contractor 12 cents per superficial foot for the dry wall, the stones to be large and with a reasonable number of through stones. On figuring up the extent of the wall from the rock bottom to the underside of the cellar concrete, and deducting the footings, it is found that 138 superficial feet will be required, which at 12 cents per foot would be $16.56. A special contract is drawn up and signed by both parties, and a note made on the cellar plan and in the superintendent's field book; it is agreed that the payment shall be made (ten) days after the last payment on the original contract shall have been made, and after the final acceptance of the work by the architect and owner.

The excavation for the pit and trenches are next measured up, and, as this work could not be foreseen at the time or previous to the signing of the original contract, the owner will be required to pay for this extra work also. By measurement it is found that the top of the rock near the pit is 4 feet 2 inches below the natural surface grade, which at this point is uniformly level. After measuring at several other points along the trenches, it was found that a fair average of the depth of the earth above bed rock is 3 feet 6 inches; taking this as the depth, the superficial area of the trenches and the pit measured—making trenches 2 feet wide to allow a workman sufficient room—amounts to 81 square feet. The

price for earth excavation agreed upon is 30 cents per cubic yard; thus,

$$\frac{3 \text{ ft. } 6 \text{ in.} \times 81 \text{ sq. ft.}}{27} = 10\tfrac{1}{2} \text{ yd.} \times 30\text{c.} = \$3.15.$$

The rock excavation in the pit and the cut to the pit is found to contain approximately $3\frac{3}{4}$ cubic yards, which, at $2 per cubic yard, the price agreed upon, will give $7.50 for rock excavation; this amount added to that for earth excavation brings the total to $10.65. The coarse gravel filling which he will get after screening that taken from the excavation for the cellar is not charged for, and the contractor agrees to furnish the necessary straw.

On the north side of the excavation, in the dining-room extension, a clump of rock appears above the level of the cellar bottom, and measuring it by means of a straightedge, level, and rule, it is found to contain approximately 4 cubic yards; it will be necessary to remove this to a depth of 1 foot below the level of the finished cellar bottom to allow for leveling up the bed and for the concrete to be laid to the full depth, as required by the specifications.

Now, as the specifications do not call for the excavation of solid rock, the clause being "excavate all earth and loose rocks," etc., the owner will be required to pay the contractor extra for this work. The contractor is consulted, and a price of $1.50 per cubic yard is agreed upon; hence, 4 cubic yards $\times$ $1.50 = $6. To cover this work, a special agreement is drawn up, similar to that provided for the work in the pit and trenches. A detailed specification is also drawn up, and both of these papers are signed by the owner and contractor. The superintendent makes a marginal note on the cellar plan and keeps a record of the transaction in his field book, which may be produced when the time arrives for settling the accounts. These matters being satisfactorily adjusted, the contractor may proceed with the work.

32. Rock Excavation.—Rock excavation being too small an amount to warrant the use of steam or compressed-air drills, and too extensive for wedging, hand drills will

have to be resorted to. The small holes are driven by one man with a small jumper and a hand hammer; the larger and deeper holes require three men, two with sledge hammers and one holding the jumper, which he lifts up slightly and turns at each stroke of the hammer to keep the hole round and prevent the jumper from jamming. A small amount of water is poured into the hole at intervals to wet the pulverized stone; this is cleaned out several times in the course of sinking, and when the hole has reached a sufficient depth, the pulverized stone and water is removed by means of a rod having a valve or a spoon-shaped piece on the end. The hole is then cleaned out with a rod or strong wire having straw or rags wrapped around the end. After throwing in some fine, dry sand or some such material to absorb the remaining moisture, the hole is ready for the charge. Coarse gunpowder or dynamite is generally used for the charge, the latter being preferable where it is required to shatter the rock, on account of its great strength and also its comparative safety in handling and storing. If a heavy charge of black powder is used and the charge improperly covered, the rock fragments are likely to be thrown in all directions, while dynamite has an apparent tendency to work downwards, due to the greater rapidity of the combustion and consequently a greater resistance of the atmosphere. The size of the cartridge depends on the depth of the hole, the amount of rock to be blown out, and the nature of the rock itself; harder rock very often requiring less than rock of a softer nature. Where a comparatively small amount of rock is to be excavated, the charge is generally set off by means of a fuse, cut to a sufficient length to allow the workmen to reach a place of safety before the explosion occurs; but if dynamite is used as the explosive, the charge is fired by electricity, a cartridge being secured to the end of the wires which are strung along to a suitable distance to insure safety, and the charge exploded by means of a button or plunger handle.

Electricity is used almost entirely where a great deal of blasting is to be done, the holes being driven during the

morning hours and the charge inserted and connected up with the battery to be set off at once, generally at the noon hour when the men have quit work for lunch; the same procedure is gone through with in the afternoon and the blasts all set off at the quitting hour. Where a great deal of rock is to be excavated to a reasonable depth, it is worked to a face and the holes are sunk at a distance back and parallel to the face; in this way the rock may be excavated with economy, and the rock excavated will be of greater value for building purposes. When rock excavation is done on a large scale, steam or compressed-air drilling machines are used, the work being done with greater rapidity and economy. Rock excavation in the larger cities is done by men who follow that business entirely, being licensed and placed under a penalty for noncompliance with the local ordinances, or for carelessness. In work requiring a great deal of rock excavation, the quarryman becomes a subcontractor, unless the contracting mason himself is a licensed stone quarryman.

33. Quarry Stone.—After completing arrangements for the blasting of rock and special work in trenches, etc., as previously described, the superintendent examines the quarry stone delivered, and finds that it is for the most part sound and of sufficient size. With an admonition to the contractor to allow no shaky or unsound stone to be used anywhere in the buildings, and to see that all stones are laid with a good flat bed, he passes on to inspect the footing stones and finds that they are flat, sound, and up to the requirements. Some pieces found to be only 6 inches thick are condemned, as the specifications require that they shall be at least 8 inches thick. The superintendent orders these stones broken up for use in the walls, or removed from the premises; the remainder of the footing stones are found to conform to the specifications. The footing stones should be laid on the undisturbed earth, and if the earth in the trenches has been disturbed, all loose earth must be removed to obtain a firm bed, even if takes an extra course of stonework to do it.

34. Ashlar.—The part of the ashlar facing and dimensioned material delivered is next inspected, and is found, with few exceptions, to be clear, sound, and free from seams or other defects. Sand holes, or pits, very often occur in sandstones, the color of the stone varying to some extent; single pieces are often found having two shades of color. On sounding the pieces of ashlar with a hammer, the superintendent may discover that some pieces, which look in every way as good as the rest, give forth a dull sound, indicating that they contain hidden seams which are liable to open after the stones have been set; these stones he orders to be removed immediately. Sound stone should have a clear ringing sound on being tapped with the hammer. The same method may be employed in testing granite and blue limestone for copings, steps, etc. Good granite should be free from black or white lumps, generally of quartz, called *knots*, and also from seams or discolorations. Bluestone should be free from discoloration, which generally appears in streaks, and from decided laminations. Generally speaking, a newly fractured piece of stone should show bright, sharp, and in most cases crystalline. A reasonable period of time should be given after the stone is quarried and before it is set, to allow for the evaporation of *quarry sap* or natural moisture in the stone. Sandstones, limestones, etc. can be prepared and finished at the works by the use of saw planers, cutters, and grinders, but granite, trap rock, or similar hard stones must be finished by hand.

It is the duty of the architect to see that a copy of the working drawings, having every dimensioned stone designated by some distinctive mark, is furnished to the foreman setter by the stone contractor or quarryman, and each stone should have a corresponding mark upon it. It is also important that the clerk of the works should examine the marks on the stones as they are delivered on the ground, and see that it is placed in a position to be accessible when wanted, without the necessity of rehandling.

35. Brick.—The brick are next examined by striking two of them together. If they give forth a clear ringing

sound and the corners do not break off easily, they may be considered good, and in compliance with the specifications. Some may be of a light color, indicating that they are underburnt; others of a purplish tinge, giving forth when two are struck together a metallic ring; these bricks then are overburnt and should not be used except perhaps as *bats* in the body of the wall, or for paving. Excessive burning generally reduces the bricks in size and often distorts them. The contractor should be notified to remove from the premises the underburnt brick and all the overburnt that are distorted, and he should be cautioned to get a better quality for the balance of the work, under penalty of having the entire lot condemned. After these instructions have been given, the second visit may be considered at an end.

The superintendent should follow a systematic tour of inspection; probably the best being to examine all outside work about the excavation, such as lines, etc., then the excavation itself, examining the soil, the nature of the ground on which the footings will rest, and finally the materials in and about the premises. Each successive visit should be followed in the order named, and in this way very little will escape his notice.

THIRD VISIT.

36. The superintendent finds on the occasion of his third visit that the foundation walls have been started, a short section being built varying in height above the footing course from 2 to 5 feet; he examines the lines stretched between batter boards to see that they are in the proper notches, and then sights along the partly built wall to ascertain if it is built to the lines; finding it to be properly lined up, he enters the excavation.

The masons are busily engaged in one corner setting footing stones, and the superintendent finds that this is a good opportunity to observe how they are being laid. He sees that the stones are good, sound, and of sufficient size; he stands on each stone in turn, and tries to rock it; one stone rocks perceptibly, indicating that it is either unfit as a footing

stone or improperly laid. The stone is ordered taken out, and it is found to be slightly rounded on the under side; the masons are instructed to scoop out the gravel bed to conform to the shape of the stone, which is then replaced and is found to bed firmly. The superintendent directs the workmen to heap fine gravel and sand around the stone, and tamp it under the edges for the purpose of filling up empty spaces and improving the bed.

Another method for bedding footing stones very often resorted to is this: Sand or gravel is heaped around the stones and water is poured on it, generally by means of a hose; the water, settling under the stones and following the open crevices, carries the grains of sand or gravel with it, filling the voids and interstices between the stones and the earth beds, in this way forming new beds to conform to the uneven surface of the stones.

The superintendent finds in one place a small clump of soft rock, some 10 inches high and 3 feet long, that has not been excavated to the level nor even shelved to receive the wall; he immediately calls the foreman mason's attention to this point, and on being asked why he allowed such work to be done, replied that the rock being so near the level of the cellar bottom and the wall bed portion of it nearly level, he did not think it necessary to cut it out; for if on finishing the cellar bottom it was found to come above the floor, the projecting part might easily be knocked off with a chisel. Now it can be readily seen that if this was allowed to remain, any surface water finding its way down to this rock, would follow it and enter the cellar. The superintendent should order the wall above the rock taken down and rebuilt; the rock, which is found to lay in seams, is easily pried out with a crowbar until the required level is reached.

37. Damp-Proofing.—It very often happens that damp or wet soil is encountered in excavations for buildings, and many methods are adopted to keep the cellar walls dry and prevent the entrance of surface water. Under ordinary circumstances gravel filling and a porous tile drain along the

footings are sufficent to carry off the water, but when the soil is wet a damp-proof course of some substance that is impervious to water is applied. Asphaltum is perhaps the best known substance for the purpose, and when applied hot in layers, alternating with tarred felt paper at the footings and at a point about 6 inches above grade, the exterior walls below grade plastered over with cement mortar to even up the surface and then coated with asphalt, a water-tight job will result that under ordinary conditions will last for an indefinite length of time. Many other methods are employed in damp-proofing, but that work is discussed in another section.

Damp cellars, however, are usually an inexcusable condition, and should not be allowed to occur under any circumstance, as they are likely to cause an unhealthy condition in the house. In cold weather such houses are hard to warm, and in summer they are damp and the air has a stale, musty odor. Damp cellars result from spring or surface water penetrating the foundation walls or concrete of the cellar bottom. Water soaking through the foundation walls may be prevented by damp-proofing, as already described, but when a running stream of spring water finds its way across the building beneath the concrete bottom, it should be confined in a close drain and never carried through an open drain. The drain being open would offer the same objection as though it were omitted entirely. Where the earth in the cellar bottom is generally wet, a series of porous-tile drains should be laid connecting with a trunk drain, which in turn should be carried to some convenient place on the premises to discharge into a dry cesspool, or some such collecting basin, and where the water may soak away into the soil below.

38. Walls.—The superintendent observes that the brickwork for the cross-walls in the cellar, as well as that for the enclosing walls of the ash-pits and around the jambs of the cellar entrance door, have been started and are properly bonded into the stonework, the bonding courses of the brickwork are laid at proper intervals, and that the joints are

struck in a proper manner on each side of the wall, that is, by holding the trowel in a diagonal position, so that the joints will be *weathered* against possible water or dust. The superintendent passes on and finds that the foundation wall in course of construction is well built, that the stones are generally of good size and laid with a level bed, that there are no long vertical joints which would be objectionable, that the wall has the requisite number of through stones

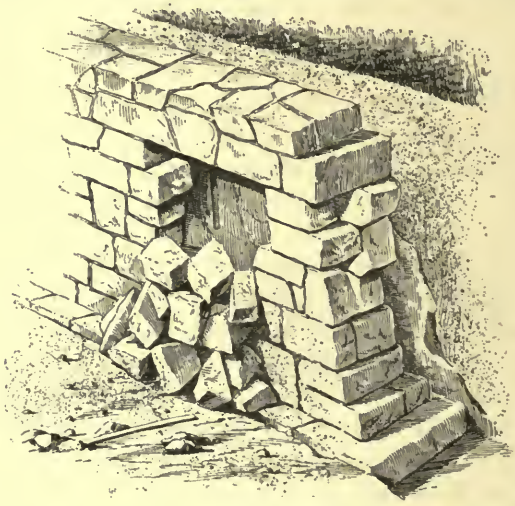


FIG. 8.

built in, that it is weather-pointed on the outside as required by the specifications, and that the footings are all that might be wished for. The filling outside the foundation wall has not been done, it being required by the specifications to leave the excavations open for at least three days to allow for inspection of the work, and also to allow the mortar to partly set.

A trick practised by some irresponsible builders, to be guarded against, is this: Where the cellar excavation is cut in rock it often happens that the rock when it shows a good vertical face is not excavated far enough to admit of the foundation wall being built to its full thickness; the rock is faced, as it were, instead, and, unless the superintendent

has been fortunate enough to discover it in time, no indication of the sham work will appear unless perhaps at some future time when it may fall away below the top of the rock, due to the action of water keeping it constantly saturated, or due to a great superimposed weight; the wall may fall away gradually or collapse suddenly to the possible risk of human life, and damage to the building, as shown in Fig. 8. A deception of this kind may be discovered as follows: The superintendent should procure a steel rod about 5 or 6 feet long and from $\frac{3}{16}$ to $\frac{3}{8}$ inch in diameter. If the wall is properly built to a line on the outside, the rod may be easily driven down to the required depth, and if the rod strikes solid rock at more than one trial before reaching the footings, the wall should be ordered taken down, and no doubt the discovery will be made that the wall is faced as shown, or else the wall is built against the face of the rock without any intervening space, which is almost as bad. In cases of this kind the only remedy is to take down the wall to the bottom and remove the rock sufficiently to leave a space of at least 8 inches outside the wall to allow for pointing up the joints, and afterwards fill with gravel or broken stone. Another common occurrence is to build the wall to one face only, that is, to a line on the inside or cellar side of the wall, allowing the stones to project out beyond the outer face of the wall as they will; the reasons for doing this are very readily understood. It not only saves a considerable amount of stone dressing, but also a great deal of time in lining up the wall, as well as saving the labor of pointing on the outside. When work is done in this way, the earth bank, if of loose material, will, when it settles, tend to force the joints in the wall by the leverage on them, and again, the projecting rock forms ledges inviting the water to penetrate the joints which cannot be well pointed to prevent its entrance. It might be well to mention here that due precaution should be taken to see that the pointing up of the outside of walls is properly done; workmen as a rule seem to shirk this part of the work, preferring to expend their skill in making the inner and actually less important surface appear well to the eye.

39. Mortar.—The lime to be used in mortar should never be slaked on the bare ground surrounded by a ring of sand as is often done in rural districts, but seldom where the best results are required. A rectangular box of plank should be constructed for the purpose; four or five planks laid on the ground with their edges butted close together, and the sides and ends formed by planks about 10 inches wide set on edge are sufficient. The box is made about 4 by 7 feet, this size being large enough for slaking and working one barrel of lime. Some masons have well constructed boxes and carry them about from place to place. Should it be required to mix the mortar in quantities requiring more than one barrel of lime or cement at a time, the boxes may be increased in size to suit the conditions.

The superintendent should make sure that the sand, lime, cement, etc. are mixed in the proper proportions. In mixing the mortar, the workmen or foreman should be instructed to put all the water on the lime at once, instead of by bucketfuls or by means of a hose. The best method is to provide a barrel that is large enough to hold a sufficient quantity for the complete slaking of one barrel of lime; the barrel may be refilled by a hose while one batch of mortar is being prepared, and in that way the water will be at hand when it is required for the next barrel of lime. If the lime has partly slaked and water is then added, the process of slaking will be stopped and the lime is liable to become chilled, and a granular paste will be the result. If this is used in wall plaster, it will cause the surface to chip off, due to the small particles of lime slaking on the wall.

It would help the quality of the lime paste very materially should the pen be covered with a canvas tarpaulin or some such device while the lime is going through the slaking process, for lime in slaking generates considerable heat and vapor, which if confined in the manner described, will tend to reduce the mass to a smooth paste free from lumps or grit. The slaked lime should be allowed to stand as long as circumstances will permit before adding the sand, which, when added, should be in a proportion of not more that 2 parts to

1 of lime paste; if the sand is added to the dry lime, it may be 5 to 1 of lime, as the lime attains, approximately, $2\frac{1}{2}$ times its bulk in slaking.

For cement mortar the superintendent should see that the sand and cement are well mixed in the dry state before any water is added. Of course it would be impracticable to make a cement mortar by reducing the cement to a paste (neat cement mortar) and then adding the sand, for the cement would begin to set before the sand could be added. The proportions of cement and sand are usually measured by shovelfuls, or barrelfuls, the former being objectionable for the reason that in making mortar in the proportion of 3 of sand to 1 of cement, the mason foreman will, as a rule, put a small, weak man shoveling the cement and three large, strapping fellows shoveling sand, with a result which is obvious to any one. Again, the cement should not be added to the lime mortar until it is desired to use it, as the cement will begin to set as soon as it is wetted. The presence of streaks of lime or cement in the mortar is an indication that the mass has not been thoroughly mixed. Lime paste if allowed to stand will remain practically unchanged for months. Machine-made mortar is the best for all purposes, as the ingredients mixed in that way are more thoroughly incorporated than is possible by means of the hoe and shovel.

40. Concrete.—Although no concrete will be laid at this stage of the work, the methods employed in preparing it and the proportions of its ingredients might better be explained at this time, while the student's mind is occupied with allied subjects following mortar, that this class of work may be kept together for convenience in referring to it at some future time.

According to the specifications covering this work, the concrete is to be prepared as follows: (1) Body of the work, Rosendale cement 1 part, sand 3 parts, and 5 parts of clean broken stone of a size to pass through a 2-inch ring. (2) Top dressing or finishing coat of Sayler's Portland cement, and sand in equal proportions, measured dry. Care

should be taken to see that the cement and sand are well mixed in a dry state; the water is then added, and when the mass has been thoroughly worked, the broken stone is added. The stone should be washed with a hose, to remove any dust that may have collected on it and to facilitate the work of mixing. The concrete is mixed in plank boxes similar to those used for mixing mortar; where a great deal of concrete work is to be done, machines are generally employed for the purpose as a matter of economy.

The method of laying the concrete will be explained when the building has advanced to construction to the stage when concrete should be laid.

FOURTH VISIT.

41. The specifications require that no filling shall be done outside the cellar walls for three days after the walls are built; the reason for embodying such a clause in the specifications was to give the superintendent due opportunity to inspect the outside face of the wall, to see that the stones were properly laid and pointed up, and to allow the mortar to partly dry out. If this clause had not been provided and the contractor wished to cover up the poor work, the filling would in all likelihood have been done as the walls were built, and the superintendent would have to resort to a steel rod or a crowbar to probe for projecting stones; by this method of sinking the bar at intervals, to say 1 or 2 feet, along the wall, the existence of projecting stones would be readily ascertained, in the event of which the filling should be ordered removed or the wall taken down and rebuilt. (Another method of inspection when the filling in is done before the walls have been inspected, consists of excavating pits at intervals along the wall.) If the walls are built and the filling in hastily done, the superintendent's suspicions should be aroused and he should satisfy himself by testing, as just described, to ascertain if the walls are built to a line on the outside, rather than take it for granted or accept a workman's word for it. The superintendent then inspects the walls—part of

which by this time have been built up to the grade of the lawns and leveled to receive the ashlar facing. He examines the lines and satisfies himself that they are at right angles to each other; that they are parallel to the axial lines *A B* and *C D*, Fig. 5, respectively; that they are at the proper distance from the building, measured from the axial lines, and that the top of the rubble wall is finished at the proper level. Satisfying himself that all the lines and levels of the terrace walls and trenches are correct, he next examines the walls as far as built. The stone is good, and the mortar which had partly set is of good quality; he passes on and inspects the trenches which have been excavated to the proper depth all around and the bottom leveled to receive the footing course; the soil here is, for the most part, of hard gravel, or fine sand with occasional indications of marl. The soil in the bottom of the trench at the southwest corner, directly opposite the parlor extension of the building, is of a clayey nature, and is wet and soggy, which no doubt is caused by the same spring which was encountered in the cellar excavations. The superintendent directs the workmen to dig deeper here and very soon rock is encountered; the water which has collected is bailed out to determine in which direction the water flows, and when the rock is exposed, it is found that it enters at the east end of the pit, just excavated. The workmen dig along the trench down to the rock in the direction from which the water enters until the water oozes from the side of the trench; on digging a little further it is found that the rock surface rises towards the normal bed of the trench. The workmen are ordered to stop digging here and to start at the other end of the pit; after digging a few feet it is found that the soil becomes drier, and digging a little further to make sure of getting firm good earth bottom, the workmen are ordered to stop. Now, as was explained heretofore, this extra digging and the subsequent work of footings and wall below the level of the trench bottom, will be charged for extra; it is necessary, then, for the superintendent to measure the pit in order to ascertain the amount of earth to

be excavated and the amount of extra masonry required to start the walls from the rock bottom. Footings will be charged for extra, as the superintendent decides to put in an extra course, laying the first course longitudinally in the trench without mortar, the upper, or regular, footing course laid in the regular way to break joints with the lower course. The upper course should be leveled up in the usual way with spalls and cement mortar, and the rubble walls then built to grade. If it was found that the water entered the trench to any extent, the only satisfactory way to overcome the difficulty would be to divert the flow of water in another direction. It has been found by experience to be almost an impossibility to confine the flow of water from springs in excavations so that it will find an outlet through the earth in some other direction.

In one of the excavations for the New York and Brooklyn Bridge piers, springs were encountered, and in laying the concrete for the substructure, the water forced its way through in several places and finally broke through solid concrete 2 feet thick. After several attempts had been made to control the flow of water, provision had to be made in the foundations to allow the water to follow its course.

42. Settlement in Masonry Walls.—A very important point in connection with masonry construction is the settlement of walls, piers, etc., due to the mortar joints being compressed by the superimposed weight and the contraction of the mortar joints in setting. If walls are built having sections varying in height to any great extent, this matter of settlement will become an all-important one. It is very readily understood that a wall 20 feet high will settle considerably less than a similar wall 50 feet high. This application of the laws of gravitation should be kept in mind in the setting of stone lintels, sills, mullions, and columns, the last named in connection with a built-up wall. For instance, if a mullion stone or one-piece column is set in an opening, the jambs of which are constructed of a large number of stones and no provision is made to make a thick mortar joint top and bottom,

the weight of the wall above is liable to crack the mullion or column, as the case may be; or, if they are strong enough to withstand the weight, the sills on which they rest are liable to be broken. A clear space of ½ inch, if possible, should be left under all sills and other stones in like position, bedding them in mortar only on the ends, to be underpinned and pointed at completion of the work. If this precaution is taken, the likelihood of their being broken is lessened considerably. Stonework laid with joints of different width would be objectionable on account of its unsightly appearance. Lime-and-cement mortar for the higher walls, and cement mortar for the lower walls, used with the view of their construction in settlement, would be objectionable on account of the difference in color of the mortar, and the judgment required as to the proportions of lime, cement, etc. that is needed in the mortar to produce the desired result. It is claimed that lime-mortar joints will contract from one-eighth to one-quarter of their thickness according to the weight imposed upon them. To obviate excessive settlement the superintendent should see that the requisite number of through stones are built in at proper intervals and that suitable long stones are built in at all external angles of the walls as far as practicable.

A practice which is very common among masons, and which should be prohibited, consists of scraping up trowelfuls of small fragments of stone, brick, and dirt from the ground or scaffold and filling the interstices between the wall stones, then covering them up with mortar. A wall built in this way is not nearly as strong as one in which the crevices are first filled with mortar, a spall of suitable size fitted in, pressed or hammered down, and then covered over with mortar, putting in more spalls if necessary to bring all to a uniform level. No two pieces of stone in a wall built with mortar should be laid without having a cementing layer between, in this way bonding all well together. Another point to be guarded against is the practice of disregarding the lines through negligence or carelessness and getting the wall out of alinement and afterwards bringing it up to

the line, thereby causing a depression or other such fault which at a glance betrays the existence of poor workmanship.

No stones having a concave bed as shown at *a*, Fig. 9, should be allowed in any part of the work, for in settling, the weight above is liable to break the thin edge.

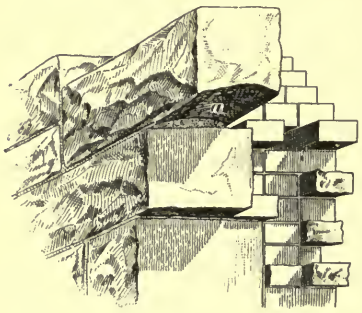


FIG. 9.

Suitable openings, covered by a good stone lintel, should be left in the walls, where indicated, for all pipes, etc. passing through the wall. These openings are often overlooked in preparing the drawings, and when it is required to lay the pipes, large ragged openings are broken through the wall at the risk of starting the joints in the wall above; besides this, breaking through the wall and rebuilding incurs needless expense and delay.

43. Refilling.—The superintendent having inspected the foundation walls of the building and found them to be properly built to a line and pointed up, notifies the foreman mason that the filling in may be done, at the same time cautioning him not to use any clay for the purpose; as clay when packed against the foundation will hold the surface water, and keep the foundation wall constantly damp. Gravel or broken stone is specified for all filling against masonry walls, and is to be tamped down at every foot in height up to grade. The object of using gravel or broken stone is to allow the water to percolate through to the bottom of the footings and soak away in the soil. Puddling clay and sand are very often used for filling against walls, but where good coarse gravel is to be had in abundance, it is well to use it in preference to any other material.

Having inspected the terrace walls and given instructions in regard to the footings, the superintendent figures up the

earth excavation and extra stonework in the walls, going through the same procedure as he did in connection with the extra work of the foundation walls, including the apportioning of cost, etc. All these points being settled, he proceeds on his tour of inspection.

44. Placing Cellar Windows.—Looking over the walls of the building, he finds that the walls are for the most part built up to grade and at the southeast corner the sill-course is in position and the ashlar work has been started. Two window frames have been set in position and the carpenter who is on the ground for the purpose informs the superintendent that he has the frames set according to dimensions in the plan, checking the position of the stone sill as set by the mason, taking care to properly set and level up the frame correctly. It is very important that the mason set the stone sills correctly, that the window frames may be set in position exactly and the dimensions marked on the plans. Sometimes the setting of the frames are intrusted to the mason, and the carpenter very often discovers afterwards, perhaps too late to correct the error, that the cellar windows have not been properly centered, which, if the windows are to be centered over each other, will necessitate moving the frames above and crowding the window to one side or other of the rooms, thereby sacrificing symmetry on the interior in order to preserve vertical alinement on the exterior. If the work is properly started, and all openings properly centered in the cellar walls at the outset, the centering of windows above will be a very simple matter.

The superintendent enters the cellar and finds that the cast-iron clean-out frames and doors for the flues and ash-pits have been properly set; the pipe openings have been left in the walls, and the rest of the work has been done satisfactorily; the section of the foundation wall condemned has been properly rebuilt; the dumb-waiter shaft is built up several courses, as are also the brick piers; the footings which may be seen are of sufficient size and laid as required.

45. Derricks.—Three derricks have been erected for laying of ashlar, sills, etc., as stone, heavier than one man can handle, are to be used in the construction of the walls. The superintendent should examine the derricks, ropes, etc., to make sure that they are sound. Although this comes, strictly speaking, within the province of the contractor, it is the superintendent's duty to satisfy himself that no accidents to life or material will occur, caused by the possible breaking of a boom or a worn-out rope; he should also examine the guy lines, which are generally of steel-wire rope, to see that they are properly anchored. A good-sized tree is perhaps the best anchor for this purpose, and if it is desired to preserve the tree, it should be protected from the guy line by pieces of wood, ordinary barrel staves being generally used for the purpose. If, however, there are no trees in the vicinity of the derrick, a pit should be dug in the ground about 5 feet deep, a heavy log or timber put in, and after the line is made fast, the hole may be filled in with large pieces of quarry stone. The superintendent examines the guy lines and finds that they are sound and properly anchored. A traveling derrick is being set in position for the setting of ashlar, coping, etc. of terrace walls; the derrick is so constructed that guy lines are unnecessary. Stone cutters are busily engaged preparing material for the building, and the dimension stonework, details for which were furnished to the contractor, is well under way. The superintendent asks to see the details, and comparing them with the stone already cut, satisfies himself that the work is being carefully done; with an admonition to the stone cutters to be careful to select good sound stock for ashlar, and especially for dimension stones, he passes on to where the carpenters are at work. The corner posts, girts, etc. are cut and piled up ready for erection; the carpenters are sizing the floor joists, and it is clear that this part of the material will be ready for erection when required. The superintendent inspects the lumber that has arrived since his last visit and finds that it is straight and sound with a few exceptions; the defective pieces, some having bark edges and

others shaky with a loose core, unfit for use, are ordered to be removed. The brickwork is next examined, and it is found that the bricks are sound, hard, and satisfactory in every respect and greatly superior to the first lot. The steel **I** beams which are to be used as girders supporting the first floor joists have been delivered, and also a sufficient number of bar anchor rods bent to a **V** shape. The superintendent's tour being completed for the day, nothing remains to be done until the work shall have progressed further.

FIFTH AND SIXTH VISITS.

46. The fifth visit being made a short time after the fourth, it will be well to pass on to the sixth visit to allow more time for the work to reach a stage of advancement in construction, to offer problems for the superintendent to decide upon. By this time the ashlar work in the terrace walls all around is pretty well along, and the walls are finished up to the terrace grade on the (west) side of the building. Rock-faced regular-coursed ashlar, pitched 2 inches on the face and having beds of 6 and 10 inches, respectively, at each alternate course, is specified for the face of terrace walls below the coping line. The coping, balusters, pedestals, and rail are to be clean-cut finished (see Fig. 13); the ashlar as far as set is as nearly perfect as it can be and care is being taken evidently to make this wall a first-class job. A few pieces of coping and foot rail are set in position, and the pedestals started; the pedestals are 21 inches square, and the specifications require that each course shall not be in more than two pieces. The work on the belvidere at the south corner of the terrace has progressed very well; all the pedestals here are set in position and everything is ready for the setting of balusters.

The circular terrace work has been started now, and this work should be laid out accurately on account of its being circular as well as being stepped down to follow the grade of the road. The superintendent sends for the mason foreman

and questions him about it; the foreman tells him that the center stake was set, the lines struck, and the center of each pedestal was designated by a stake set by the engineer who is on the ground for the purpose of testing the lines and levels of the several terrace walls with reference to their proper alinement and levels; and to locate stakes to which the ground shall be graded. The engineer is sent for and asked to test the accuracy of this circular wall, for the benefit of the superintendent. According to the drawings the center line of the pedestals is 64 feet $1\frac{1}{2}$ inches from the center, which in turn is a fixed distance from the front of the building. The end of a steel tape is held on the center stake, and the tape is run out until the required radius has been found; this is applied in turn to each stake, representing the center of the pedestal, and all being found correct, the foreman is told to proceed with this part of the work with all possible dispatch consistent with good workmanship. The superintendent proceeds to the building and finds that the walls under the plaza at the front of the building have been built up above grade, stone templets inserted on the inside of the walls, and pockets left for the **I** beams which are to carry brick ashlar to support the concrete floor above. The porte-cochère foundation wall, as well as the rubble-stone piers for the veranda, are built up to grade; the superintendent satisfies himself that they are properly built, and, putting down his extension rule, finds that when the grading is done their depth will be 4 feet as required. He passes on around the building, and finds that the porch piers and cellarway have been built, and the coping set in place. In passing around, the superintendent, while critically examining the exterior walls of the building, observes that the sill of one library window looks as though a chip were knocked off; he keeps this in mind, and on entering the building he mounts the staging and finds that a large piece has been knocked off the sill; the foreman is called and told to have the damaged sill removed although the window jambs have been built up more than 2 feet above it.

47. Protection of Stonework.—If this sill had been protected with a piece of board as soon as it had been set in position, the expense of replacing it with a new one and rebuilding the wall would have been saved to the contractor. The foreman is cautioned to cover all the projecting stonework with boards, to protect them from falling pieces of stone or other material. It might be well to mention here that no boards, such as Georgia pine or other such woods, containing a large amount of resinous sap should be used; for the action of the sun is likely to drive the sap from it and discolor the stonework which it is intended to protect. Hemlock also discolors some stones, and should not be used; white pine is perhaps the best.

All flights of steps in the premises should be protected by a substantial boarding, and all such flights that are not required to be left open shall be railed off until all the work is completed and the cleaning down commenced. The windows and door openings are all built up several courses above the sills, the sills are looked after to see that a space is left beneath them; the brick joints should be plumb and built up on a line with the check of jamb stones in window and door openings, so that, when the time arrives for setting the frames, they may be put in without cutting them or the brick jambs.

A tour of the walls is made by the superintendent, and the backing and ashlar, as well as the mortar, are critically

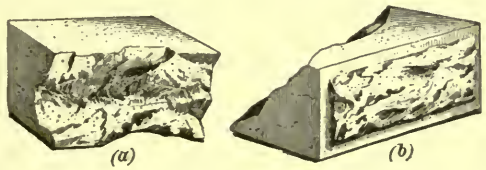


FIG. 10.

examined. The superintendent discovers, in his journey around the walls, a piece of ashlar which when first looked at appeared all right, but which proved afterwards to have a

deep concave depression at the back as shown at (*a*), Fig. 10. The bed of this stone is only 6 inches and at the center cannot be more than 4 inches owing to the depression; it is therefore condemned and ordered removed. Another form of defective stone is shown at (*b*); although the lower bed may be large enough, the upper thin corner is weak and not up to the requirements, the specifications stating distinctly that the stone shall be from 6 inches to 10 inches deep in the wall. The object of specifying ashlar to be furnished in two thicknesses and to be laid in alternate courses is for the purpose of obtaining a bond with the backing which is not possible when ashlar of uniform thickness is used.

48. Anchors.—The ashlar having a wide bed, very few anchors will be necessary except where very high stones are used, and any stone more than 12 inches in height must be anchored. In the body of the wall the anchors are to be spaced at intervals of 4 feet in length and 2 feet in height. The anchors are usually made of flat pieces of galvanized strap iron, about 1 inch wide, and from $\frac{1}{16}$ to $\frac{3}{16}$ inch in thickness; a good anchor being $\frac{1}{8}$ inch thick. They are turned up about 2 inches on the inner end and down about 1 inch on the outer, or ashlar, end; this end of the anchor is hammered together to fit into a hole drilled in the top of the ashlar. The thinner the ashlar used the more anchors will be required, and, for fronts of marble or other expensive stones where an ashlar sometimes as thin as 2 inches is used, every piece of ashlar should be anchored to the backing. Knowing that the walls below the water-table were built to the correct lines, all that remains to check the accuracy of the first-story walls is to measure the projection of the water-table on the exterior beyond the face of the first-story wall. The walls of the main building, from grade to the top of the water-table, projects 2 inches beyond the foundation and first-story walls, both of which are on line. In a heavy, driving rain storm the water flows down the face of the wall, and, if a drip is provided as shown in the cut at *a*, Fig. 11, the water

will drop off and soak away in the ground instead of following along down the walls. Pockets are left in the wall to receive the ends of I beams, girders, and joists. The I beams and the joists have been set, and the framing of the first-story floor as well; carpenters are cutting in bridging between the joists as required by the specifications; one stage has been erected for the masons to work from, the wall averaging, in height, about 5 feet above the first-story floor. Anchor bolts have been built into the walls of the dumb-waiter shaft for the purpose of anchoring a 4″×8″ plate; this plate to be laid so that the top will be in line

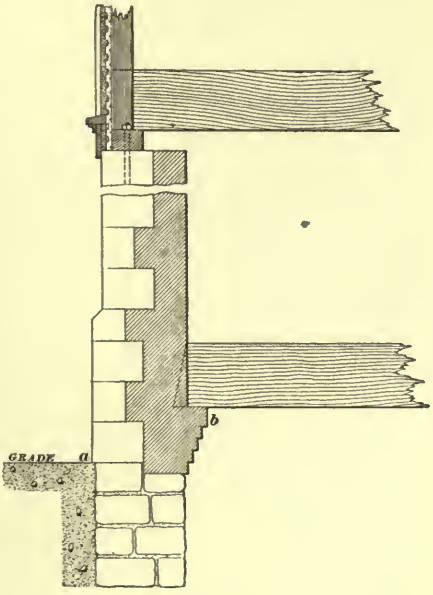


FIG. 11.

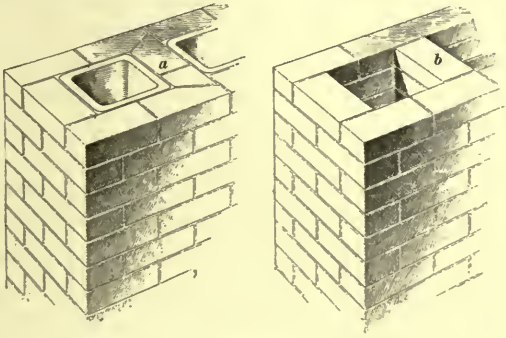


FIG. 12.

with the floor joists and acting as a sill for the frame walls to be erected upon it. The interior chimneys have been stopped off at the first-floor level, and the flues are lined with

fireclay pipe as required. The superintendent examines the flues of all chimneys to see that all are lined with fireclay pipe and that the withes are bonded into the body of the work as at *a*, Fig. 12, and not merely set in as at *b*.

49. Corbels.—The brickwork has been corbeled out at the first-floor level shown at *b*, Fig. 11, which forms a firestop as well as affords additional bearing for the joists and girders. The superintendent enters the cellar and finds that laborers are at work leveling up the earth bottom; two laborers are at work collecting and breaking up the fragments of rubble stone, left by the masons, to be used in connection with gravel in making concrete for the cellar bottom. The stones are being shoveled against a screen having a 2-inch mesh to get them as nearly uniform in size as possible, and to remove dirt and grit.

The brick piers are completed and have the bond and capstones built in as required. The cellar window openings have a three-row rowlock arch over each, and the door opening to cellarway, and interior door openings are arched over with a rowlock arch of four courses. The sill and lintel in dumb-waiter shaft are of the requisite size, and are properly built in with a 4-inch bearing on the ends.

50. Other Stonework.—Having inspected all the work on the building, inside and out, the superintendent walks over the premises to inspect any new materials that may have arrived in the interval; he finds that a number of finished balusters, coping, foot rail, and upper rail, in dimension blocks and caps for the pedestals of the terrace balustrade, have been delivered on the ground. This stonework was cut and dressed at the quarry, shipped by railroad, and the cars run onto a side track. The stones were hauled to the premises in wagons, each stone is marked in the back, or bed, with a number or letter, which designates its ultimate location when set in place, and *lewis holes* are cut in all except the balusters, which have round holes drilled in for dowel-pins.

The under side of upper rail and top of foot rail also have

holes drilled at regular intervals for dowels. The workmen are laying the long pieces of rail and other members in tiers of two or three high, with a piece of board between, as these stones, being long and small in cross-section, are liable to break easily. The superintendent examines these stones and finds that all are of good sound stock and have no broken edges, or corners which if found would render the stones as unfit for use. A large quantity of cement has arrived and is placed on the ground as it is unloaded from the wagons; the superintendent examines the labels on the barrels and finds that they are of the brand selected at the time the tests were made; he directs the workmen to remove the cement at once to the temporary shed prepared for it. A number of steel I beams have arrived, and judging from their height and length, the superintendent decides that they are for the plaza at the front of the building. Further on, a large number of square fireclay flue linings of different sizes are tiered up; two or three of these have large pieces broken off the corners, and for this reason are condemned; a workman is called and told to set these to one side for removal, as they are unfit for use; a small corner or a chip knocked off would be of no consequence. There appears to be a great deal of activity along the street line of the premises as a large force of workmen are excavating the trenches for these walls. Rough quarry stone is heaped along the line of this trench several feet inside the property line, and for the most part this stone is found to be sound and excellent for the purpose of building the rubble part of the walls. Going along the trenches, the superintendent finds that the soil is mostly of a sandy loam, approaching to gravel as a greater depth is reached, with boulders of varying sizes here and there; the soil in the trenches, as far as they are excavated, is found to be dry. Passing around to the avenue side of the premises, the superintendent notices that a large quantity of floor joists, studding, and other lumber has been delivered, and has been deposited directly in line with the main entrance. The foreman carpenter is called and shown that the lumber cannot remain here for more than a few days

at the most, as the masons will be along to excavate for and build the walls. He is therefore ordered to remove all this lumber to a clear space out of the way of other trades, and cautioned to see in the future that his lumber is deposited at the proper place. Having attended to all these matters, it is safe to say that the superintendent has finished his labors for the day.

SEVENTH VISIT.

51. The superintendent visits the premises again after a few days and finds that, with the exception of two lengths of rail and three pedestal caps, the west terrace wall is completed. The method of jointing the work in construction is shown in Fig. 13. The piers, columns, and lintel course on the belvidere are set in position, ready for the wood framing of the roof.

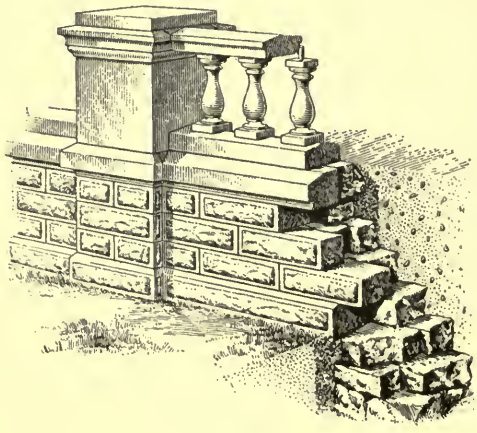


FIG. 13.

Quite a stretch of coping and foot rail has been set and the pedestals started on the south-front terrace wall near the belvidere. The curved terrace walls have been built; especial attention having been given to rush this part of the work, as the stakes indicating the centers of the pedestals were liable to be dislodged by wagon wheels or otherwise. The wall at each side of the main-entrance driveway is to be built of coursed ashlar, clean-cut finished; the rubblework has been built up to grade, and preparations are being made to start the ashlar.

The terrace walls on the east side and the stretch of wall on the end near the stable are pretty well along; the ashlar is being set, and the coping, rails, etc. are being deposited

along the line of this wall to be at hand when required. The superintendent observes that but a few men are at work on the main building. On asking the foreman mason for an explanation of this, he is informed that very little headway could be made on the building, as neither the capping course, or facia, nor the voussoirs for door arches had been delivered. On the contrary, a large quantity of the stone for the terrace walls was on the ground, and for this reason the men were ordered to push work on that section of the work in order to dispose of the accumulated material. Very little work has been done on the building since the superintendent's previous visit. The arches and lintels over the openings have been set with the exception of those over the doors; the templets for which are in position.

52. Street Wall.—Nothing further being done on the building, the superintendent proceeds to the Station Street side of the premises, where the masons are at work on the street wall. This wall is stepped up 8 inches at intervals of about 50 feet, in order to conform to the grade of the street, and no part of the foundation wall is to be nearer than 4 inches to the finished grade of the sidewalk, that no rubble-work will appear. The wall on the front, or avenue, side of the property is being pushed along rapidly. The base course along the street walls is to be of bird's-eye granite, clean-cut finished, having $1\frac{1}{2}$ inches projection, and leveled on top, and the balance of the stonework of the same kind of limestone as that used in other walls on the premises. All street-wall pillars to be capped with a single piece of stone, those for gate pillars to be molded and finished with a ball on top, and all coping between pillars to be in one piece, having a 4-inch cover at each end; granite wheel-guards to be built in at each pillar, flanking the carriage entrances. By constant observation of the quality of the stone on the ground, and mortar used in the work, as well as occasional investigation with a light steel rod driven down into the crevices from the top of the wall, for the purpose of testing the bonding, it will be a comparatively easy matter to follow up the work and

see that no sham, dishonest, or careless work is being done.

53. Stable Foundations.—Proceeding to the rear of the premises, the superintendent finds that the work on the stable foundations is being properly done. It is not our intention, however, to dwell on this part of the work, for the general methods of construction are the same as those in the main building. Only such details of construction as are not covered in the main building will be explained. The same remarks may apply to the greenhouse, the construction of which, as was previously mentioned, is the subject of a separate contract. This class of work is done, as a general rule, by men who make a specialty of it, and as a number of devices used in this construction are patented and controlled by the horticultural builders, it is advisable to let the work absolutely to them. The excavation for the wall at the rear of the stable and greenhouse is being done; the soil here is found to be dry, and solid rock is struck about 2 feet below grade, immediately at the rear of the greenhouse. As the solid rock affords the best known foundation, the wall may be built upon it without laying footing stones, the rock to be shelved to form a level bed for the stones of the wall. This wall is built of ordinary rubble stonework up to grade, and with buff pressed brick above grade. The capping consists of limestone coping with cover joints, as shown in Fig. 14, and each end of the wall is finished and strengthened by a pier

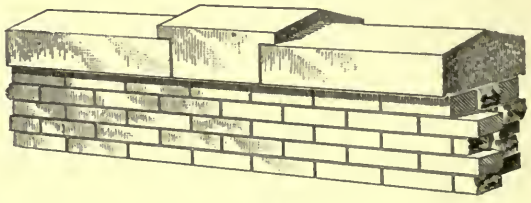


FIG. 14.

capped with a single stone and ball top to conform to the other work. This wall is built for the purpose of screening this section of the premises from the view of the adjoining estates.

54. Hedge.—Instead of building this wall the full length along the dividing property lines, a hedge of a close growing shrub will be planted, which, if kept neatly trimmed, will serve the purpose of a wall or fence. The inspection of the work being concluded for the day, the superintendent makes a tour of the premises with the view of examining any new or additional materials delivered since his last visit. He finds a number of large casks marked enameled brick, "bull noses," "stretchers," arch "A," etc., each barrel being marked to designate what form of brick it contains. This enameled brick is to be used for facing the inside walls of the carriage room in the stable, and as they are not to be used for some time, and are very liable to be damaged if the casks are left open, it is decided to inspect them when they are to be used, for any damaged brick is very easily detected; those having chipped edges should be rejected. The window and door arched brick, should be laid out on a platform to ascertain if all required for the arches are at hand and that they are molded to the proper form, so that when assembled they will fit the opening exactly.

The carpenters have stopped work, as the framing timbers required for the floors, roof, etc. are ready for erection when masons have finished their work on the main walls of the building.

A large quantity of sheathing boards have been delivered and are found to conform to the specifications; being matched-surfaced one side and of good sound stock; a few boards have split on the ends, due to improper handling perhaps, but these may be easily culled when the time arrives to cover the frame with them. These damaged boards may be used for bracing of staging, rough bracketing, or some such purpose.

Several thousand buff hydraulic-pressed brick have been delivered, plank have been laid on the ground to protect them from the earth and dampness, and they are tiered up with fine salt hay between to prevent breakage. These bricks, being pressed in a mold under great pressure, are uniform in size, and when pressed in the same mold seldom vary

more than $\frac{1}{8}$ inch in size. The inspection of this quality of brick is a comparatively easy task. They should be sound, have sharp angles and corners, free from flaws and from lumps of gravel, etc., at least three faces smooth and true, and all be of a uniform color.

55. Drain-Pipe Trenches.—The trenches for subsoil leader and sewage drain pipes on the premises are being excavated, but only the laying of drain pipes required to be done by the mason will be considered at this time. The iron drain pipes and other work of that nature will be explained under the head of plumbing work, to which they properly belong. Nothing more remains to be done for the day, so the superintendent's visit may be considered at an end.

The work on the remainder of the terrace and other walls on the premises being practically a repetition of that previously described, nothing further need be said on the subject, except, perhaps, as regards some details of construction not previously described.

EIGHTH VISIT.

56. During the period occupied by several visits of the superintendent to the premises, following the seventh visit, which was described at length, a great deal of work has been done. The street walls are all built up to the level of the terrace slope, the coping set in position, and the pillars completed with caps set in position; the caps for the pillars at the carriage entrances have not been set, and the superintendent learns that they had been delivered and they were found to be too small, having been cut to the same dimensions as those for the intermediate pillars, while they should have been much larger.

The superintendent passes all along the street wall and examines critically that part of the work done since his last visit, and not finding any improperly done or faulty in any way, he proceeds to inspect the terrace walls which are completed all around with the exception of the sections at the

steps. He discovers in one flight that a step has been set which has a large piece broken off near one end. Work on this section has been stopped; the foreman probably discovered the broken step and expected that it would be condemned. The foreman is called and is told to have the step removed. On looking over the plans, the superintendent notices that the entrance steps at the front carriage gate are of the same rise tread as in the flight mentioned above, and, as the condemned step is sound, the foreman is told that it may be used in the front flight of steps by cutting it to the right length.

Passing on, the superintendent's attention is attracted to a workman who seems to be busily engaged in rubbing on one corner of a pedestal; this arouses his suspicion, and going over to him finds that a piece was broken off the corner, and this man had patched it and was trying to cover up the joint when discovered. The superintendent orders the man to desist, and notifies the foreman to remove the stone and replace it with a sound one.

57. Laying Bricks.—The manner of laying bricks depends largely on the character of the work. As a general rule, all joints should be filled with mortar and made as small as is consistent with good work. They should never be less than $\frac{1}{8}$ inch in thickness to insure a good bond. Nine courses of standard size common brick laid up in an ordinary wall should not measure more than $23\frac{1}{2}$ inches. When the outside courses have been laid the full length of the wall, the bricklayer should fill the space between with mortar and then lay the heart bricks, pressing them with a downward diagonal motion so as to press the mortar into the joints. The surplus mortar is scraped off and thrown ahead. This method of laying is conceded to be the best. On account of the true rectangular form of pressed brick, they may be laid with a close joint, but $\frac{1}{8}$ inch should be the minimum. Before laying face brick in the wall a sample should be laid up in the colored mortar to determine the height of a fixed number of courses and get the proper

tint, after which the proportion of mortar stain can be determined.

58. Rear Wall.—The brick wall at the rear of the premises is seen to be built up several courses above the stone base course, and as this wall is to be faced on both sides with the light pressed brick previously described, it is well to look after this work and see that the bonding is properly done, and that the wall is built to the proper lines. The superintendent examines the lines and finds them to be in the proper position with reference to the stakes set for the purpose, and the wall at the corners and the ends is carried up several courses above those in the body of the wall. A careful workman is generally put at each corner or end of the wall, so that they may adjust the lines as the courses rise up; the men on the intermediate sections then have only to work to the lines as they are set for them, as shown in Fig. 15.

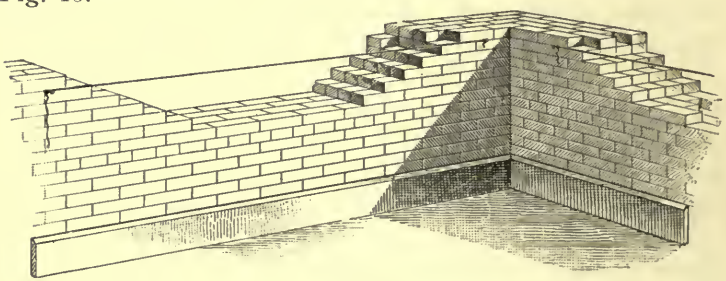


FIG. 15.

The body of this wall is laid up in lime-and-cement mortar, and the face brick in mortar tinted with mineral mortar stains to match the brick. The face brick being of standard size, a good bond with the common brick filling may be very easily obtained; about every sixth course the wall is laid up in regular bond, every sixth course in height being a header course. The wall is capped with a 5-inch coping with cover pieces 7 inches thick, having a 2-inch lap as shown in Fig. 14.

59. Greenhouse Foundations.—Work on the greenhouse foundations is in progress. At one end, towards the

stable, considerable rock is encountered, in one place appearing above the surface, but as the greenhouse floor and the exterior grade about the greenhouse are to be fully 3 feet above the driveway, which is nearly on grade here, the walls may be built upon the natural rock by shelving it to form an even bed for the first course of stone.

Some rock will have to be excavated in order to get 8 feet of headroom in the cellar under the central pavilion, as required by the drawings, but as the rock appeared above the surface at this location, the contractor for the work will have to excavate it at his own expense. The earth in the trenches at the western end is of a sandy loam and is firm and dry; a footing course will have to be laid here, but where the rock occurs none will be required.

60. The Main Building.—The superintendent goes to the main building, the mason work on which by this time has to all appearances been completed. Passing clear around the building, he sees that all the stone facing voussoirs in door arches, and the belt course capping the wall have been set in place.

The steel **I** beams and brick arches for the support of the plaza are in place, and all properly set and lined up; the walls here have been built up and part of the coping is set in position. The porte-cochère, veranda, and porch pillars have been set, and the **I**-beam framing for the veranda floor is being set. The stone slabs forming the floors of the porches, and the balustrades at the sides are in position.

Having completed for the day the inspection of the works in course of construction, the superintendent looks about him for new or additional material that may have been delivered in the interval. He finds that the stone caps for the pillars flanking the carriage entrances have been delivered, and applying his rule to them, finds that they are of the proper dimensions. A gang of laborers are at work breaking stone which is to be used for laying the bed of the driveways. The engineer and his assistant are at work staking out the driveways, and, on consulting the

landscape architect, who is supervising this work, the superintendent learns that the excavation and rough shaping of the driveways is to commence at once.

NINTH VISIT.

61. On the occasion of his next visit, the superintendent finds that the street walls and entrance steps are completed; the terrace walls, with the exception of a few details, are completed; and as the rubble foundations of these walls have dried out, the foreman is called and told that the filling in should be done at once, that the work of road building may not be delayed, as this work is being done by another contractor. The rear dividing wall is built about half way up and the work is being pushed rapidly; the superintendent inspects this work, and finds that in one section of the wall a joint three courses from the top is found to be too wide—the specifications requiring that all joints in face brick in this wall shall not exceed $\frac{3}{16}$ inch in width. The courses above this point are ordered taken down, that the objectionable joint may be remedied. Passing on, he watches the bricklayers and finds that one of them is simply filling the walls with bats without using any mortar until he has a number of them set, when he throws a trowel of mortar on, and working it back and forth with his trowel, trusting to luck that the joints will be filled; then scraping off what remains, he throws it ahead, and spreading some more mortar further on, attempts to repeat the process, but is stopped by the superintendent, who asks him how much work he has done in this way. The foreman is called and questioned about this work, and he assures the superintendent that the rest of the work was properly done. The latter, to satisfy himself, orders the wall taken down for two or three courses and he finds that the work here was done as required. He then cautions the men that the bricks must be shoved, as required by the specifications. The superintendent directs the foreman to allow no more work of this kind to be done under pain of being compelled to

tear it down again; he makes a note of this order in his field book for future reference.

The wall coping and cover pieces of same are on the ground, and are up to the requirements of the specifications. A V-shaped groove is cut under the projecting edge to form a drip. The stable walls are pretty well along, the corbel in the walls on the inside for the support of the first-floor joists is built in, the marble base has been set, and the enameled brick are well laid and properly bonded into the body of the wall. The superintendent passes all around on the interior of the carriage room to see that no chipped or otherwise damaged brick is used. The foundation walls of the greenhouse are built and leveled ready for the superstructure; a large number of cases containing glass has been delivered and also a large quantity of painted structural iron.

Going around to the front of the building, the superintendent sees that men are at work laying the cement top dressing or floor of the plaza; at one end the cement is laid and a man is marking it off with V-shaped channels to represent a pavement.

62. Fireclay.—Fireclay is a composition having as its principal ingredients aluminum and silicic acid, which form about two-thirds of the mass; it also contains water, quartz, and oxide of iron. The clay is mixed with sand and water, molded into the required shapes, and burnt at a white heat; this product is called "firebrick." With an addition of about 40 per cent. of sawdust, or some other combustible material before burning, the product is called "porous terra cotta" or "terra-cotta lumber." Pipes are made from this material in a variety of sizes and shapes, but usually round. They should be straight, sound, and of a uniform thickness in cross-section. Pipes, for the purpose of sewerage, or other uses where a tight job is required, should be formed with a socket at one end and a spigot at the other, and when fitted together should show a circular space, or ring, of at least $\frac{1}{2}$ inch clear all around between the two. These pipes

should be glazed with salt put on before burning, and then fused in.

63. Laying Pipes.—The work of laying earthen pipes should be carefully done, and the superintendent should pay a reasonable amount of attention to see that the bed of the trench is made smooth and with a uniform pitch. If the trench is cut through rock, the bottom should be covered with a layer of sand about 6 inches deep; the sand is scooped out for the hub or socket, and the pipe should be laid so that its entire length will have a bearing; mortar is then placed around the bottom half of the socket, and the top half of the spigot and the pipes are set in. The mortar should be pressed back into the joint to fill all crevices, and then the scraper drawn ahead, as shown in Fig. 16. The scraper may

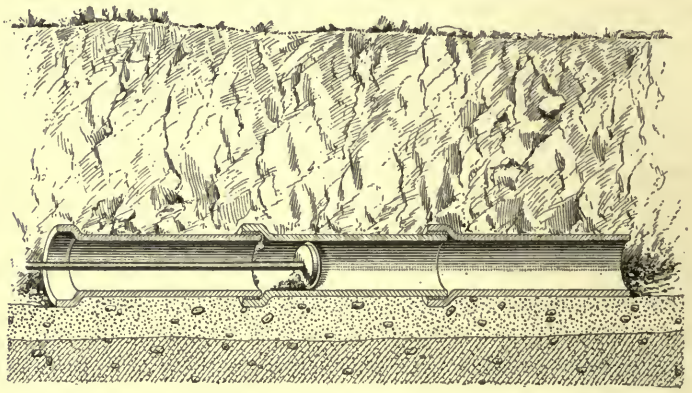


FIG. 16.

be made in different ways, but the one shown in the figure is very easily made and serves the purpose very well. A circular piece of wood with a leather or sheet-rubber edge tacked on, is attached to a handle, and as each length of pipe is laid, the scraper is drawn ahead and takes any mortar, that may have entered through the joint, with it. As soon as three or four lengths of pipe are laid, they should be covered with a layer of sand free from large stones to a depth of 2 or 3 inches, to protect them until they are inspected by the

superintendent, after which the filling in may be done with any degree of rapidity desired.

Porous or agricultural drain pipes are laid in much the same way. The pipes are made in various forms and sizes, and usually without hubs. They are often laid on rough planks in the trenches in order to prevent settlement or dislocation. The ends are simply butted, leaving about $\frac{1}{8}$ inch between, and the joints are covered with a strip of oilcloth or paper to prevent the entrance of earth into the drains. The filling over these pipes generally consists of gravel sand, broken stone, or similar material, that the water may find its way to the drain and in that way be carried off.

64. Road Building.—The position and grade of the roads and paths were determined at the outset and indicated on the drawings. The first part of the work consists in removing the top soil along the line of the roads and adding it to the pile already taken from the several excavations, to be used for the final grading. After this is done, the roads are cut through the high ground and brought down to the required grade, always working to the stakes set by the engineer. Trenches, 18 inches wide and 2 feet deep, are dug on each side of the roadway, as shown in Fig. 17, the excavated clay or loam being thrown to either side, and the gravel or sand into the middle of the roadway. The trenches are then half filled with broken stone over which a layer of straw is laid, and then topped off with gravel sufficient to fill the trenches. These trenches, sometimes called "French

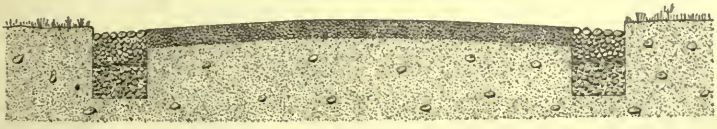


FIG. 17.

drains," should be continuous, crossing one another under the road at intersections, if necessary. If broken stone and gravel are not available, an agricultural tile drain may be used instead.

The object of providing the trenches is to protect the road from the undermining influence of water entering at the sides. It is often found to be economical to construct the roads while the excavation for the building is being done, so that the excavated gravel, sand, or loams may be used immediately, and thereby save rehandling it. After the work on road beds and drains has been completed, work should be suspended until the time arrives for final grading; the road bed being finished to an even surface 6 inches below the finishing level. The drains will keep the roads dry, and the constant traffic over them will compress the beds so that when the top dressing of gravel is applied and brought to a neat surface, the finished road will be durable and with a reasonable amount of attention will require no repairs for some time. The gutter formed at each side of the road is paved with small cobblestones, as shown in Fig. 17, for the purpose of carrying off excessive water during heavy rain storms.

65. Pointing.—All joints in stonework should be raked out to the depth required by the specifications and pointed up with Vicat Portland cement. This, and also a compound of cement, lime, plaster of Paris, and marble dust, called La Farge, are both used for setting and pointing up the joints of stones that are likely to be discolored by ordinary cement. The mortar should be well pressed into the joint and "tucked" with a steel jointing tool having a converse working edge. The work of pointing should be carried on simultaneously with that of cleaning down. The horizontal joints in coping, as, for instance, the plaza coping, or other joints in a similar position, where the mortar is liable to drop or work out in the course of a few years, should be calked with oakum to a depth of 2 inches and then be filled with about $\frac{3}{4}$ inch of mastic cement having asphaltum as a base.

If it is desired to clean down old walls, a sand blast is generally used; the sand being driven against the wall in a spray by compressed air or steam. By this means a layer is removed from the stone, which may be increased until all

stains or nicks are removed, leaving a surface similar in appearance to that on the stone when first cut. When carving is to be cleaned down by this process, it is necessary to have a careful man to do the work, as the fineness of the carved forms may be very easily destroyed.

66. Cramps, Joggles, and Dowels.—The methods of tying or linking stones together by means of stone or metal are various, and as an adjunct to, or even sometimes in the absence of mortar, have been practised for ages. Theoretically, blocks of stone used in the construction of buildings should, when their beds are level and their faces vertical, preserve their position from the fact of superposition in obedience to the simple laws of gravitation, without a binding medium between them, such as mortar or mechanical devices.

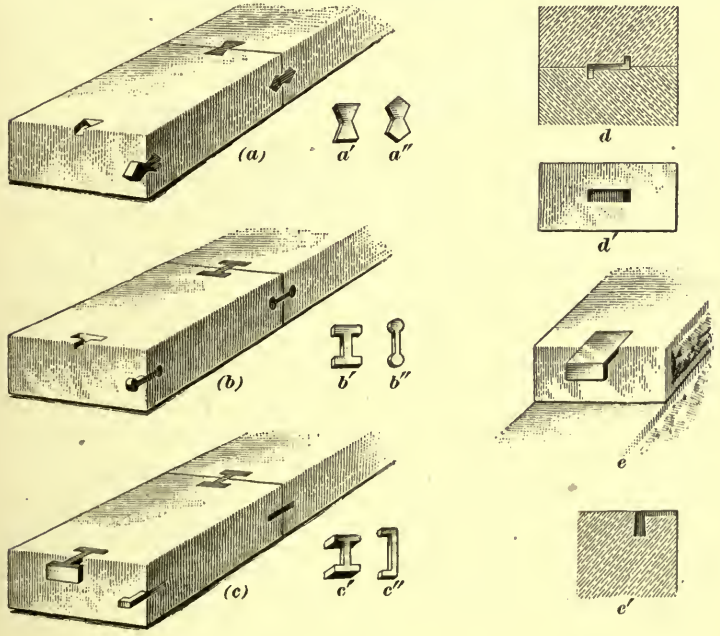


FIG. 18.

In Fig. 18 several forms of cramps are shown; a', a'' represent cramps which are made of a tough stone, and at b, c, d,

and *c* the forms shown are usually made of metal, and for this reason they are not as large as stone cramps; at *d'* and *e'* are shown how the stones are cut to receive the cramp.

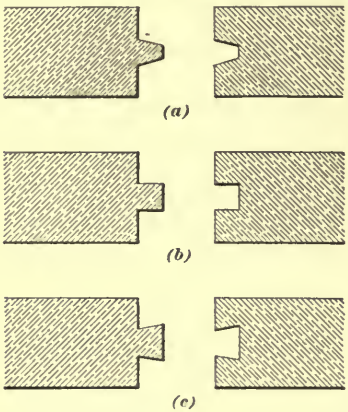


FIG. 19.

Bronze is generally used for making these cramps, and is perhaps the best metal for the purpose; iron or steel will rust and discolor the stone. Joggles in stone jointing are cut in various shapes, but the slip, or mortised, joint shown at (*a*) and (*b*), and the dovetailed joint at (*c*), Fig. 19, are the forms most common. Dowels are made of metal, stone, or wood. The common form of metal dowel and its use in jointing stonework is shown at *a*, Fig. 20, while *a'* shows the dowel itself. At *b* a square dowel serving a similar purpose is shown. At *c* and *d* two pieces of stone cut to receive dowels are shown, *c'* and *d'* being the dowels. It is always well in constructing stonework to use mortar to insure a perfectly secure job, but dowels, joggles, and cramps are necessary and are used very extensively in the construction of intricate stonework, such as in the tracery of Gothic windows. The fitting of dowels, etc. should be very accurately and carefully done, especially when they are exposed to view. The cramps should fit neatly, be flush with the surface of the stone, leaving an annular space around the cramp to receive molten lead. When the lead has cooled, a sharp cold chisel and hammer should be used to chip it down to a smooth surface. Dowels or cramps, when in a position where lead cannot be poured in, should be fitted snugly and set in cement to fill the crevices about the dowel.

67. Concrete Work.—The specifications require that the body of all concrete shall be mixed in the proportion of 1 part Rosendale cement, 3 parts sand, and 5 parts of broken

stone of a size to pass through a 2-inch ring; the finishing coat, or top dressing, to be mixed of sand and Portland cement in equal bulk, measured in a dry state before mixing. The bottom for all concrete work should be prepared and tamped down thoroughly before laying concrete anywhere on the premises.

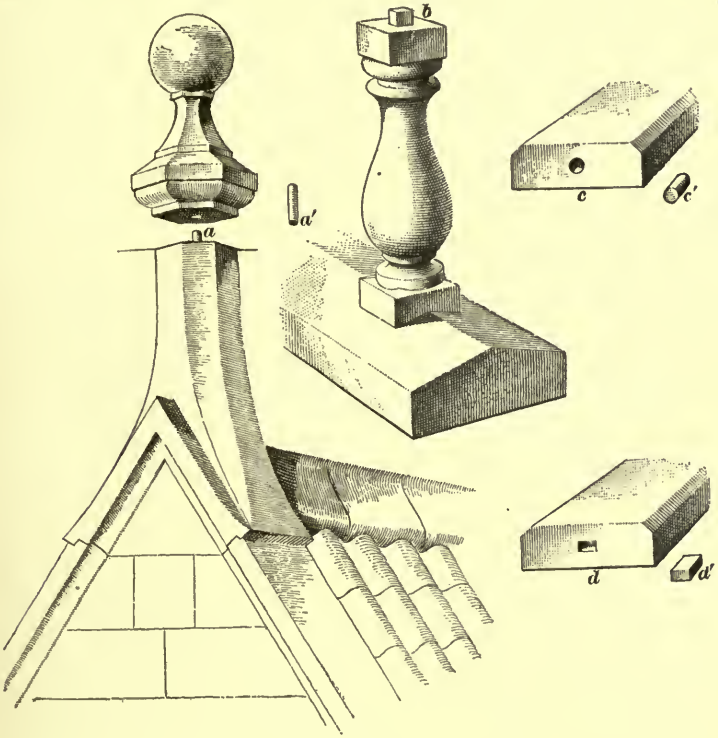


FIG. 20.

The bottom for the concrete in the carriage wash consists of 2-inch tongued-and-grooved plank, supported by 4″ × 8″ girders, which in turn are supported on a stone wall built around under the carriage wash. The top of this rough flooring is 6 inches below the finished floor of the carriage house. A water-tight bed is laid over this, consisting of alternate layers of tarred paper and asphaltum; these layers are turned up 4 inches all round. A ½″ × 2″ wrought-iron

bar secured with screws is placed around the edge of the floor to form a stop for the concrete and to preserve the edges from breakage. After the waste-pipe connection and the strainer have been set by the plumbers, the body concrete is laid and tamped down, the top being graded to conform to the required finished grade, but 1 inch below it. After this has set sufficiently, the top dressing is laid, smoothed down nicely, and graded to the strainer. A series of **V**-shaped diagonal channels 4 inches on centers are marked on the surface of the concrete, to prevent the horses from slipping and to drain the stand, as shown in Fig. 21.

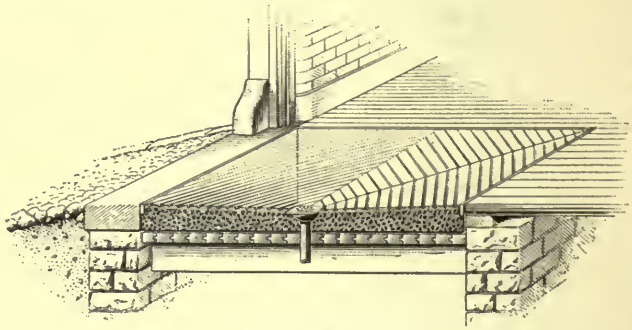


FIG. 21.

The concrete in the cellar bottom and area is specified as being 6 inches thick including a 1-inch top dressing. The superintendent should see that the body of the work is well tamped down, graded as required, and worked up close to the foundation walls, piers, etc. The laying of the finishing coat must be carefully watched to see that no depressions occur on the surface, that the required thickness is put in, and that the top is properly floated to a perfectly smooth surface and finished neatly around all angles and corners. The walk *e*, Fig. 3, leading to the front entrance; the platforms *f*, flanking the front carriage entrance; the plaza floor *g*, previously described; the veranda floor *h*; the bottom of trap wells for the service and drainage lines and the bottom of the manure vault—are all laid and finished in a manner similar to the cellar bottom. The platforms *f* are finished

with a rounded edge at the sides adjacent to the drive, and these platforms, as well as the walk *e*, are squared off to represent flagging.

The superintendent should, during the laying of the concrete work, pay strict attention to the proportions of ingredients used and the methods of laying it, as perhaps no other work in masonry can be skimped more than this. It might be well to add that all concrete work after completion should be protected from damage by covering it with boards, and, if necessary, fenced off with a rough temporary guard.

68. Flagging.—The platform in front of the greenhouse is laid with flagging in two pieces the full thickness of the steps; the pieces to be of equal length with the joint in the center; these stones are to rest on the foundation walls of the greenhouse on one side and be upon the steps at the other. A manhole, 20 inches in diameter, is to be cut on the left side where indicated, and a cast-iron frame and flush cast-iron manhole cover to be inserted. All this work is included in the contract for the greenhouse work, but the laying of the platform, with respect to getting proper grade and beds on supports, should be closely watched by the superintendent. The flagstone covers over the trap wells for the service-pipe lines are specified to be 6 inches thick and in one piece, with a full 8-inch bearing on the walls all round, and to have a manhole with cast-iron flush frame and cover; the top of these stone covers to finish 10 inches below the finished road bed. The superintendent should see that the stones are sound, of sufficient size, that they are properly bedded, and laid at the proper level.

INSPECTION OF LUMBER.

69. Classification of Lumber.—The *inspection* and *classification* of lumber, or its valuation according to the uses to which it may be put in house building or elsewhere, is, for the most part, a matter of judgment. In every locality, however, there are certain rules adopted by the lumber

exchanges and associations which the inspector must follow, as far as his judgment will allow, in classifying the lumber. It would require too much space to give the rules of inspection in each state or locality, so that those of only three lumber centers will be given—the Maine inspection for the East, the Baltimore inspection for the South, and the Saginaw inspection for the West. These will serve to give the student a general idea of the grading of lumber, and will enable him to read, intelligently, specifications or proposals making use of such classifications.

MAINE INSPECTION.

70. Pine.—No. 1 pine is entirely dispensed with, and the first quality recognized is called No. 2.

No. 2 pine may be of any length or width, provided, however, that short lengths and narrows must be good; the shorter and narrower the board, the better is the quality required. A board 12 feet long and 5 or 6 inches wide must be entirely free from knots and sap, and must be straight in grain. Larger boards must be nearly free from knots, sap, and shake.

No. 3 pine must be free from shakes, but a few knots or a little sap will not condemn it. The size of the board goes far to determine the quality; very small pieces, otherwise up to grade, would be classed as No. 4.

No. 4 pine is a small board usually free from knots, but with some sap. If large boards are put in this number, it is because one-quarter or one-third of the piece is shaky, although the remainder may be good.

The market recognizes, also, two kinds of shipping boards, designated "Shippers"; viz., smooth and common. *Smooth shippers* are boards without shake or case knots, or any large knots. *Common shippers* are boards coarse and knotty, 8 inches and upwards in width, and 12 feet and upwards in length. (These are sometimes manufactured under special orders, when they may be 9 inches, 10 inches, or even

greater widths.) In this grade splits, red streaks, or very shaky boards are objectionable.

Narrows is the term of the next grade below common shippers, and consists of boards too small for shippers. These must not be very coarse, and must be suitable for floor boards.

Poor fours consist of sappy, shaky, and knotty boards, not suited to be classed in any of the foregoing descriptions.

Scoots are the lowest grade; rotten boards and all others not admissible in other grades are surveyed as scoots.

The market also handles what is termed *sapling pine* or *gang boards*. These are usually manufactured in gang mills, the survey as to quality being about the same as the balance of the grades described, except as to designation, the twos, threes, and fours being put together under the one term *planers*. The *shippers*, *narrows*, *poor fours*, and *scoots* are surveyed as described in those heads.

71. Spruce.—Spruce is known in the two qualities of *merchantable* and *scoots*. The scoots comprise boards which are cross-grained or rotten. In surveying, the grades are divided into two qualities; viz., *floor boards* and *coarse*. The floor boards must be nearly free from knots; all others are considered coarse.

BALTIMORE INSPECTION.

72. Rules.—The following rules for the inspection of lumber were adopted by the lumber exchange of Baltimore:

In the inspection of hard-wood lumber it is essential that the inspector use his best judgment, based upon the following rules laid down for his guidance.

The standard knot must be a sound one, and not exceeding $1\frac{1}{4}$ inches in diameter. Splits are to be considered as defects, and usually reduce the piece to a lower grade. Mill culls are never regarded as marketable, and any cull which will not work to the use for which the size is applicable, without

wasting more than one-half, is a mill cull. The standard lengths are 12, 14, and 16 feet, but 15 per cent. of 10-foot lengths may be allowed.

In black walnut and cherry, 10-foot lengths are considered as standard, and 15 per cent. of 8-foot lengths may be admitted in the first and second grades.

All badly manufactured lumber should be reduced in grade, and that for newels must be inspected with a view to the adaptability of the piece for the intended use, as in many cases it cannot be utilized for other purposes. They shall be cut outside of the heart to square the following sizes: 5, 6, 7, 8, 9, 10, and 12 inches when seasoned. The lengths must be 4 feet or the multiples thereof.

All rotten, shivered, and shaky ends shall be cut off in measurement when the board or plank will make 8, 10, or 14 foot lengths, clear of the bad end, and be classed in the grade the part will make, except culls, which shall be counted full in all cases.

Face cracks in all cases will reduce the stock one grade; if badly face-cracked, so that one-half of the board or plank cannot be used without waste, then it shall not be counted.

The inspector, in all cases, is to keep a separate tally of each size and quality. All boards and plank should be measured and graded on the inferior side.

The recognized standard thickness shall be 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, 4, and 5 inches in all classes of hard woods, and in all cases the board or plank shall be of full thickness, parallel in width and have square edges and square ends.

All tapering pieces of lumber shall be measured one-third the distance from the narrow end, when 12 inches and over in width at the center; when less than 12 inches wide at the center, they must be measured at the narrow end.

Worm holes are to be considered one of the most serious defects in hard-wood lumber.

All inspectors of hard wood under these rules shall mark the quality upon the lumber so inspected, when required. Lumber inspectors are required to use due care in handling and marking lumber, that the stock is not damaged in any

way, or its fitness for use impaired by careless handling or marking.

73. Black Walnut.—Black walnut shall be inspected in three grades—firsts, seconds, and culls.

Firsts shall not be less than 7 inches wide, and must be free from defects, but at 10 inches wide will admit of defects equal to 2 inches of sap on the edges. Defects may increase with the width, but not such as to cause waste when used for first-class work.

Seconds shall not be less than 6 inches wide, and at 6 inches may have one knot. Defects may increase proportionately with the width. Sap on the face side shall be measured out.

Culls shall include all lumber not up to the standard of seconds. Mill culls to be excluded from this grade.

74. Poplar or Whitewood.—Inspection grades shall be known as firsts, seconds, and culls.

Firsts shall not be less than 10 inches wide, and at this width shall be free from all defects; at 12 inches wide, 2 inches of white sap, and at 16 inches wide, 4 inches of white sap shall be allowed; proportionate increase of sap to be allowed according to the width. In lieu of the sap one standard knot shall be allowed for each 4 inches of sap.

Seconds shall not be less than 6 inches wide, and must be clear up to 8 inches. When over 8 inches they may have two sound knots not exceeding $1\frac{1}{4}$ inches in diameter, and 2 inches of white sap. At 10 inches, defects equal to 3 inches of white sap, or two sound knots $1\frac{1}{4}$ inches in diameter are admissible. Defects may increase with the width, but two-thirds of the entire piece must be suitable for use in first-class work, without waste.

Culls shall comprise all widths and sizes not up to the standard of second grade. Lumber usually designated as mill culls is not included in this grade.

For poplar, regular marketable thicknesses shall be $\frac{5}{8}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, and 4 inches; $\frac{1}{2}$, $\frac{3}{4}$, $1\frac{3}{4}$, 5, and 6 inches and

up are classed as special sizes. When squared, the sizes in inches shall be 3×3, 4×4, 5×5, 6×6, 7×7, 8×8, 9×9, 10×10, etc. All square stuff to be cut clear of the heart, clear in quality, and cut large enough to hold sizes when seasoned. Such as are not designated as prime shall be graded as seconds or culls.

75. Ash.—The inspection grades shall consist of firsts, seconds, and culls.

Firsts shall not be less than 8 inches wide, and free from all defects. Sap shall not be considered a defect, if bright and sound.

Seconds shall not be less than 6 inches wide, and at 8 inches may have two standard knots; must also be free from heart, dry rot, dote, and worm holes.

Culls shall include all grades not up to the standard of seconds.

76. Oak.—Inspection same as ash, excepting timber, in which sound knots, and heart not showing on the outside shall not be considered defects. For birch, beech, maple, elm, and hickory, the same inspection as for ash. In first-grade hickory, 6 inches in width and 8 feet in length shall be allowed. Quartered oak shall be inspected as firsts, seconds, and culls.

Firsts shall be 5 inches and over wide, and clear of all defects. At 10 inches wide will admit of defects equal to 2 inches of sap on the edges. Defects may increase with the width, but not such as to cause waste when used for first-class work. Gum spots are excluded from this grade.

Seconds must be 6 or more inches in width; will admit of two standard knots; sap on the face side to be measured out. Defects may increase with the width in proportion. Small proportion of gum spots will be allowed, but in no case shall they be of such a character or quantity as to seriously damage the piece.

Culls shall include all not up to the standard of firsts and seconds.

77. Cherry, Ash, and Walnut.—Counter tops shall be 12 feet long and over; 17 inches wide and over; 1, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches thick, and must be clear of all defects.

Cherry, ash, and walnut strips 6 inches wide and under, when in separate lots, shall be counted as firsts, seconds, and culls.

Firsts shall have one face and two edges clear. Sap on face side of ash, when bright, to be counted.

Seconds will admit of two standard knots or sap, which on face side of cherry and walnut shall be counted out.

Culls.—All not up to the standard of seconds shall be designated as culls.

Cherry strips shall be 6 feet long and over.

SAGINAW INSPECTION.

78. "Clear."—*First clear* is not less than 8 inches in width, and is free from imperfections, the term *clear* implying freedom from defects.

Second clear is not less than 8 inches in width, at which it must be so nearly perfect as to fall but a trifle short of first clear. As the width increases, a larger range of defects may be allowed, so that at 12 inches wide, a piece may have two knots of 1 inch diameter, or two narrow saps on one side; at 16 inches wide, especially if the piece is more than 1 inch thick, two knots may be allowed, or one knot and one sap not over $1\frac{1}{2}$ inches in width. At 20 inches in width, the two knots may be larger, or the saps may increase to $1\frac{1}{2}$ inches.

Third clear is supposed to admit of three defects, but up to 10 inches, knots should not exceed $\frac{3}{4}$ inch in diameter, or the sap should not exceed $\frac{3}{4}$ inch on one side. With increasing width, knots may increase to three in number, not over 1 inch each, or sap equal to $1\frac{1}{2}$ inches in width on two edges of one side; with narrower saps a small knot showing on the face side might be allowed; but as a rule, the three upper grades demand one perfect face.

In the Saginaw and some other markets the term *good* is

used in designating the upper grades, and purchases are sometimes made in *good*, *select*, *fine common*, *common*, and *culls;* but unless these terms are specified, the quality *good* in common use will include not only the three upper grades, but also the next grade below, or selects.

79. "Selects."—Selects is a term which allows of four defects in a piece of lumber. Four knots not over 1 inch in diameter, according to the size of the piece; or two saps on one side, which in pieces 12 inches wide, should not exceed 3 inches in the aggregate, or embrace more than one-quarter the sap side, the heart side being the face. With increasing width, the proportion of sap may increase; or with narrow saps, the face side may have some knots. The general description of this grade, however, is of a class of lumber which has defects of such a character, as, while condemning it for the three uppers, yet mark it as suited for many or most uses to which the three uppers may be put.

Fine common, sometimes known as *select common*, or *select box*, or merely *box*, is a grade of lumber suitable for finishing purposes, yet having too much sap on one side, or too many knots on the other, to admit its entry to the grade of selects. Fine common is usually taken from the lumber cut next to the outside of the log—sometimes known as sap boards—the general character of which is to give one face side, while the other is largely covered with sap, which, if properly piled to dry without mold, is adapted to a large proportion of the finer work where one side only is exposed to view. With this point in mind, the inspector will allow knots in this grade proportioned to the size of the piece. If the sap is narrow, the face may have one or two small knots, but, except in wide lumber, the rule is observed "one side a face." Pieces below 8 inches in width are seldom accepted in this grade, and at that width the defect is in sap, which may embrace not more than one-third the sap side and must not run out to the face side; or a board of that width may have a good sap side nearly, if not wholly, clear of knots and with two small knots on the heart side. In larger pieces, a board or plank

having too many defects for the grade of selects, and yet approaching almost to the requirements of that grade, is included in the *fine common*. A board 16 inches wide, 1 inch thick, with five knots not over 1 inch, and having no other defect, would be classed with fine common. The same piece, if 1½ or 2 inches thick, would probably be classed as selects by most inspectors. Shaky lumber is not admitted in this or the upper grades.

80. "Strips."—*Strips, first clear*, are 6 inches wide, 1 inch thick, free from all imperfections, and are known as clapboard or siding strips. The term *siding strips* should not be confounded with *sidings*, lumber cut from one side of a log, in distinction from the stock, or lumber cut from the square log.

Strips, second clear, are 6 inches wide, 1 inch thick, and may have two small sound knots, or if there are no knots, then sap equal to 1 inch in width on one edge of the one side may be allowed.

Strips, third clear, are 6 inches wide, 1 inch thick, and may have three small sound knots and upon one side in addition, sap equal to 2 inches in width. All strips in these three grades must be free from rot, split, or shake.

Strips, Flooring and Fencing.—These terms include all strips not as good as third clear, yet free from rot and split. Flooring strips must be of full thickness and width, except where a narrower width is desired, when they may be of the uniform width of 3, 4, or 5 inches. All knots in flooring strips must be sound. Fencing strips include all coarse-grade strips not good enough for flooring and above the grade of culls, or strips not up to the standard thickness, and their inspection is less rigid than the other grades.

Common.—This term includes all boards, plank, scantling, strips, joists, timber, and lumber not otherwise defined, which do not come up to the select-box grade, but are of a generally sound character, well manufactured, of full thickness, and free from large, loose knots and bad shakes. Scantling joists and timber must be free from knots or

imperfections which involve or weaken the piece for substantial building purposes. Pieces containing worm holes and small sap streaks, which do not materially damage the piece for the uses in which it is usually employed, belong to this grade. One straight split, not more than one-quarter the length of the board, may be allowed. . No lumber under 10 feet in length is considered as merchantable in this or the better grades.

81. Shipping Culls.—Lumber containing unsound knots, or knots which affect the strength of the piece, black or moldy sap, unsound hearts, and badly sawed, is included in this class, the pieces are available for coarse use, and all other lumber not up to the grade of common, is included in this grade. Anything poorer than shipping culls is not recognized in any market. Saginaw lumber is always manufactured in 12, 14, and 16 foot lengths (with an exceptional log of other lengths) in all grades, except dimension stuff where lengths are cut to suit the sizes demanded, but the sidings from such logs are usually cut off to the 12, 14, and 16 foot standard. The thicknesses of the Saginaw lumber, as usually cut, are 1, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches; but with some 3 inches in coarse plank, or in extra nice stock, for thick uppers or deals. All lumber is manufactured in parallel widths, and many mills employ cut-off tables for reducing all lengths to uniformity. The coarser grades are usually cut 1 inch thick, the better grades being almost invariably $1\frac{1}{2}$ and 2 inches in thickness.

SUPERINTENDENCE OF THE FRAMING.

82. Inspecting Material.—In framing the outside walls of this building, a modified form of balloon frame, or, more properly speaking, a combination of balloon and braced framing, will be considered. It is assumed that complete framing plans have been furnished, and the superintendent directs his attention to the inspection of the lumber to see that the several sizes specified have been furnished, and that

the quality is up to the standard required by the specifications. In order to do this, he should have a knowledge of the distinguishing characteristics of each of the various woods specified and should know them at a glance. The difference in texture of the grain, the color and the odor peculiar to each are generally sufficiently marked to enable him to do this. It should be remembered, in measuring lumber for the purpose of determining whether the proper sizes have been furnished, that they shrink to a certain extent in drying; a 12-inch floor joist, for instance, will seldom measure more than $11\frac{3}{4}$ inches. Spruce sometimes shrinks more than this. Crooked or warped pieces of timber should be condemned at once, as well as pieces showing shakes, especially those occuring along the annual rings which are very noticeable in average hemlock timbers. Longitudinal cracks that do not extend through the thickness often occur in spruce timber of large dimensions, but are caused by shrinkage or rapid drying and do not seriously impair its strength, but if they occur in a thin piece of timber, as, for instance, a floor joist 2 inches in thickness, and extend through its thickness, the timber should be condemned, as it is liable to fail along this line. Any timber showing dry rot, unless it is possible to cut off the affected part, should be condemned at once. After the superintendent has inspected the lumber and satisfied himself that all of it is up to the requirements of the specifications, his attention should be directed to the fitting together and erection of the work.

The first operation consists of laying the sills which should be of sufficient cross-section to allow for possible cutting and notching. In this case the sills are 4 in. $\times$ 8 in., to allow the anchor bolts to be set back clear of the ashlar facing; the bottom side is to be painted, and the sills bedded in a good layer of Vicat cement mortar. The sill should be leveled up by inserting spalls or pieces of slate under them until all are brought to a uniform level. The corners are to be halved together. The sill is laid on its broad side and back a distance from the face of the wall equivalent to the thickness of the sheathing. As the main sill and that for the dumb-waiter

partition are to be anchored to the walls by means of iron bolts built into the wall, holes are bored through the sills to correspond with the spacing of the bolts, and, after the sills are set in position, nuts are tightened up at the time the sill is being leveled. Before the sills are set, the superintendent should see that they are painted and that a good bed of mortar is spread under them, as mentioned elsewhere. The corner posts are erected, plumbed, and braced, after which the studding, plate, and ribbons, or false girts, are set in place. The superintendent should see that the posts are plumb, as it is very important that they should be; he should also see that the plate, ribbons, etc. are perfectly level and at the proper heights. The floor joists are now set in position, the roof framing erected, and, after all bracing is put in, the building is covered with sheathing lath as shown. This work should also be carefully watched, that no joint occurs between studs, and that the boards are well driven together and secured with the requisite number of nails. All the framing is well spiked together, and in this case, as the sheathing is to be put on horizontally, braces will be necessary. If, however, the sheathing boards were put on diagonally, they would serve as a brace, and, under ordinary conditions, would be sufficient.

83. Bracing, Etc.—Long angle braces are generally used in balloon framing, but pieces of timbers notched into the sill, plate, and post, and secured with oak pins, are perhaps of more value in stiffening a frame, and serve the same purpose. If the long brace is used, the superintendent should see that the studs are cut only enough to allow the brace to come flush with the outside face. He should also see that the requisite number of nails is used at each bearing. The rafters are braced by means of collar beams, and the floor joists are braced and stiffened by means of "bridging" put in rows about 6 feet apart and running in a line across the floor of the building. The bridging is put in as soon as practicable after the laying of floor joists and before partitions are set.

84. Floor Joists.—In the setting of floor joists the superintendent should see that they have a full bearing on the sill, in this case extending to within $\frac{1}{2}$ inch of the sheathing boards, and, although it is a common practice to notch the joists over the sill, it cannot be recommended as good construction. Joists cut in this way depend almost entirely on the section immediately above the sill, and are equivalent to a joist of that depth; for the underpinning—generally of slate or small pieces of stone wedged under the joists—is liable to work loose and drop out, thereby exposing the beam to the conditions cited above, and causing a rupture, as shown in Fig. 22. The girders under the first floor being of steel **I** beams are set in position by men under the direction of the mason foreman; one end of each is supported on a stone templet in the wall and the other end on the piers or cross-walls, as the case may be. The first-story joists are supported by these girders, and their wall ends are carried on a brick corbel, as shown at *b*, Fig. 11. The framing of the first-story joists is the first carpenter work to be done, this being laid as soon as the masons have completed the stone walls up to the sill line; in an ordinary two-story frame building, however, when the underpinning is only 2 or 3 feet above grade, the sill would be the first member to lay.

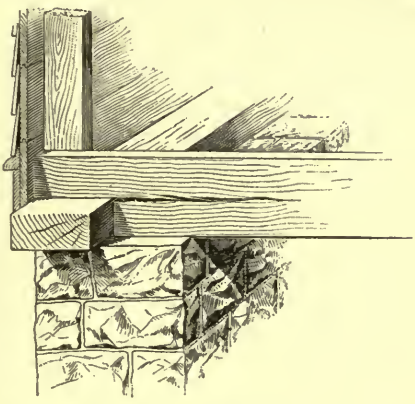


FIG. 22.

Floor joists are specified to be laid with their crowning or cambered edge upwards; by crowning edge is meant the edge trimmed with an adz so that the joist will be higher in the center, and when a load is imposed upon it, the joist will assume, approximately, a straight line; in other words, it will become level. This proceeding, however, is only necessary where joists have a large span. The joists being spaced

the requisite distance apart (16 inches), a level is applied, and the joists are notched out on the bed side, or a piece of slate or wood is inserted beneath, as the case may be, to bring all to a uniform level; the entire floor is thus brought to a uniform level. The bridging is then cut in after the joists are spiked together where they lap on the girder, or to the bearing where they rest on a sill. The superintendent should follow this work conscientiously to make sure that the floor is perfectly level throughout. The specifications require that the joists shall extend to within $\frac{1}{2}$ inch of the space of the brick backing or the inside line of the sheathing, and this should be carefully looked after. Floor joists are cut on the sill in a number of ways, each builder having his own ideas as to which method is best. Unless the specifications are drafted to cover this work, the architect is likely to be at the mercy of the builder and have the efficiency of the floor joists greatly reduced by excessive cutting or notching. In the building under consideration here, the joists are specified to rest on the sill or corbel in their full thickness without notching, except perhaps that necessary for leveling. Another evil to be guarded against by the watchfulness of the superintendent, is that of allowing the joists to rest on the inner edge of a stone wall without having a full training on the wood sill, for if the stone works loose, or falls out altogether after the building has been completed, the joist will drop down to the sill and thereby cause a depression in the floor above. Another point to observe in laying floor joists, is to have the tail-beams properly framed to the headers around chimneys and stair openings. Where the specifications require that the tail-beams shall be hung in steel bracket hangers of an approved make, the setting of the hangers should be followed closely to see that the tops (if they hang from the top of the header) are let in flush, and if otherwise hung, that they are properly spaced and set, and that the tail-beams are closely butted and spiked to the header, as shown in Fig. 23.

As the work progresses, the superintendent should verify

all measurements to satisfy himself that the openings for doors and windows are of the proper size and properly located; for a mistake made at this stage of the work in the centering of openings will be a difficult matter to rectify, to say nothing of the annoyance it will occasion. Frequently mistakes are made in locating the openings in floor framing, for the chimneys and stair wells. Special attention should be given this framing to insure a proper clearance for the chimneys, which should never be less than 4 inches, and also sufficient headroom and width in the openings for stairs.

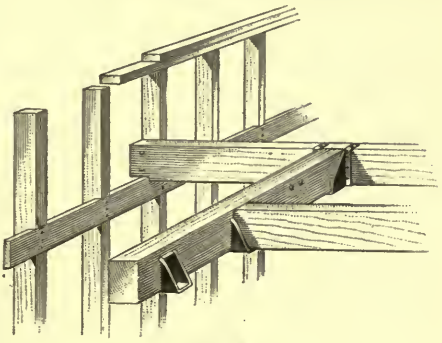


FIG. 23.

85. Staging.—Although the quality of the material to be used for staging, and the method of erecting it is usually the contractor's affair entirely, it would be well for the superintendent to see that strong material is used and that each stage is well supported and a sufficient number of stays or braces are used. Sometimes studding is used for putlogs and very little attention is given to see that sound material is used; a treacherous knot in the center of a putlog may endanger the lives of many workmen.

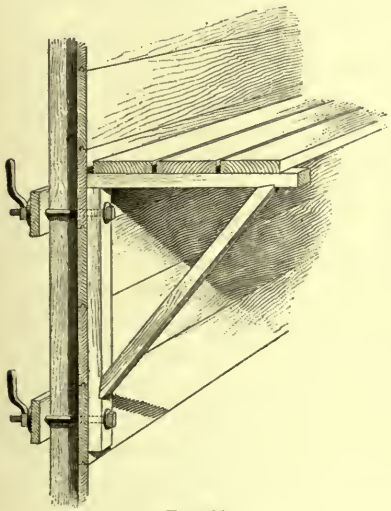


FIG. 24.

A common form of staging consists of long pieces

of studs or rough spars set in barrels, and the barrels filled with quarry stone or earth, the uprights, if too short, being lashed together to increase their length. Putlogs, generally of rough sheathing stock, are nailed to each upright and to a cleat secured to the building; over this the stage is laid with plank; a simpler and perhaps better, if not a safer, form of staging consists of portable brackets secured to the frame with setscrews, over which planks are laid, as shown in Fig. 24.

86. Roof Framing.—The superintendent should see that the rafters are all sized to the proper lengths, and that the ridge, eave, and valley cuts are at the proper bevel to make a good fit. He should also see, when the rafters are erected, that the ridge and valleys are perfectly straight and free from waves which are sure to occur unless the rafters are all cut to an exact length for each pitch. The position of the openings for dormer-windows, chimneys, etc., and their dimensions, should be checked and the headers properly framed in. As soon as the roof has been framed together, the collar or tie-beams should be cut in between to tie each alternate pair of rafters, and well spiked thereto, as required by the specifications. The studding forming the cheeks of the dormers should be notched over the rafters, spiked to the sides of same, and extend to the floor to insure a water-tight joint and prevent the sagging of the trimmers.

Nothing need be added by way of instruction to the superintendent for his guidance in supervising the work in the stable framing, as practically the same problems as those met with in the construction of the main building will appear. The framing of the roofs over the belvidere, summer pavilion, porte cochère, and veranda will of course be somewhat different in character. The veranda roof will be constructed as follows: A built-up plate of two 2-inch beams bolted together is secured to the stone columns by means of anchor bolts. The rafters are notched over this plate and against a $3'' \times 12''$ ridge pole, which is in one piece and runs clear from

the building to the outside line of the porte cochère; this ridge timber forms a support for the joists forming the floor of the deck over the veranda. The superintendent should see that the plate is leveled up and secured by anchor bolts, and that all is in alinement with the building. The roof over the belvidere and the summer pavilion are built conical in form. The first pair of rafters erected are butted squarely together on a plumb-cut, the second pair are cut in a similar manner, set at right angles to and butted against the first pair. The four remaining principal rafters are fitted in the angle formed by the first four, and the intermediate rafters are fitted in like manner to the angle just formed. As the summer pavilion and the belvidere each have a wood plate anchored with iron bolts, the rafters will be notched over it and no collar beams or braces will be required.

87. Rough Flooring.—The rough flooring of $1\frac{1}{4}'' \times 6''$ surfaced-and-matched spruce is laid after the plumbing and gas pipes, electric wiring, etc. have been set in place. The rough floor is laid diagonally and well fitted around all rising lines. Openings must be left where required by the plumber or electrician for facilitating the erection of his work, and as the running lines of gas pipes and electric wires will be laid along the top of the floor joists, the rough flooring will have to be fitted against them; the superintendent should see that this work is properly done, that the floor is laid up to the sheathing, and that the joints are made on the joists only, and not between them. A furring strip should be nailed on the inside of the studs at the level of the top of the floor joists, to which the rough flooring will be nailed, and to serve as a bearing for it.

The summer pavilion above the piers will be constructed entirely of wood. The superintendent should see that the sill is properly built up of three thicknesses of 2-inch plank well spiked together, the floor joists set level, and spaced the requisite distance between centers, and that the wood columns are sound, turned properly, and have a hole bored through the center as required by the specifications. The

floor of the summer pavilion will be laid as shown in Fig. 25.

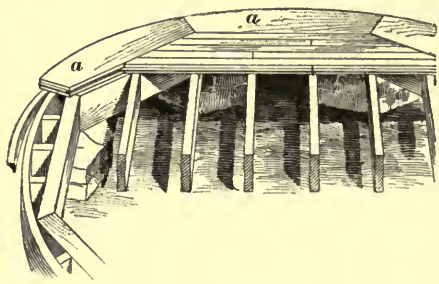


FIG. 25.

The flooring is to be of $1\frac{1}{4}'' \times 3''$ white pine, matched and laid with white lead between the joints. The pieces *a* around the edge are grooved at the back and the flooring is tongued at the ends. The floor is planed down smoothly, given a good coat of thick paint, and covered with heavy canvas duck; the canvas is stretched down, and tacked under the nosing all round, after which a bed mold is tacked on. The painting of the canvas is described under painting of outside work.

88. Partitions.—It is a common but erroneous custom to place the joists in a building without any regard to the location of partitions, and to draw the framing plans, without provision for the support of the partitions, in a manner to avoid settlement due to sagging of the floor, as shown at (*a*), Fig. 26. Another poor way of supporting a

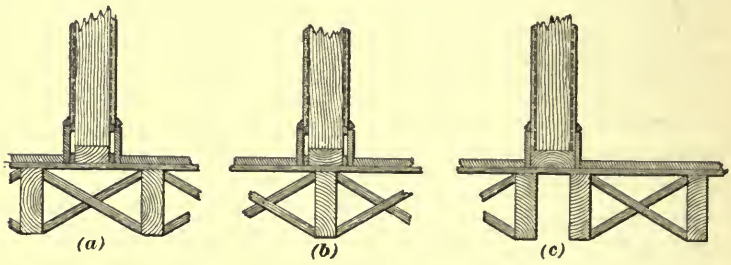


FIG. 26.

partition is shown at (*b*), and in both cases a suitable nailing for the finished flooring is not possible and in time the flooring will work loose and present an uneven surface. The method shown at (*c*) is the best, for the partition above has a good support and a good bearing is offered for nailing the finished floor. It will be noticed at (*c*) that a wide sill is

shown; this piece makes a firm support for the partition, and being made to a width to line with the plastering, it serves as a ground and the baseboard may be nailed directly to it. The superintendent should see that the studs are doubled at all openings for windows and doors in the exterior walls, and for doors in the interior, as required by the specifications, and that the rough sills and heads are put in at the proper distance above the floor to leave sufficient room for inserting the frames.

The specifications require that all partitions shall be trussed over openings 4 feet or more in width; this clause, then, would apply to the framing over the arched openings between the principal rooms.

The method of trussing is set forth on a detail drawing, and the superintendent should see that timber of the proper dimension is used and that the joints are well framed together, spiked and pinned with hard-wood pins. The door and arch openings in the interior partitions should be carefully laid out and their position checked by the superintendent. He should watch carefully the setting of sliding-door partitions, see that these partitions are lined with $\frac{5}{8}'' \times 3''$ matched white-pine boards, painted on both sides, and that the hanging timbers and brackets for the sliding-door hangers are set perfectly straight and level, that the doors when set will work perfectly true. The importance of having this work accurately set in place is very often overlooked, and the mistake is discovered only when the door is being hung; the remedy is to remove the trim on one side, and tear down laths and plaster enough to allow the guide, or hanging timber, to be set properly. All partitions are to be bridged once in their height with diagonal, or "herring-bone," braces cut in between and well nailed to them with 10d. nails.

When it is required to run vertical lines of pipes through a partition, the sill and plate of the partition should be cut by the carpenter, but no more than required to allow the pipe to pass should be cut.

In well constructed houses provision should always be

made to prevent or check the spread of flames in the event of fire; several methods are employed, but that of using brick for the purpose is perhaps the cheapest and best; by this means rats and mice are also prevented from going from room to room, and from floor to floor, through the partition.

The spaces enclosed between studs from floor to floor constitute a series of air spaces or flues through which the flames can quickly communicate with the floors above, and, in balloon frames especially, the fire may break out in the attic, when it originated perhaps in the cellar. The superintendent should see, therefore, that all spaces between the floor joists in partitions, and between furring, and around chimneys are filled in with three or four courses of brick laid in mortar, as shown in Fig. 27. Very often the brick

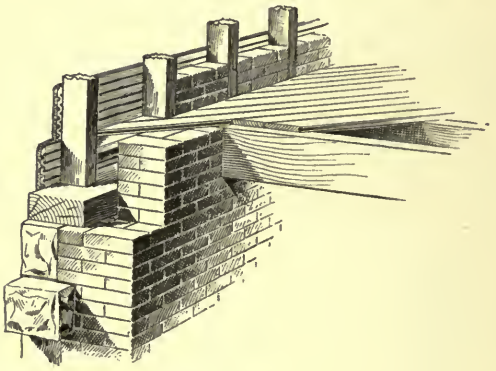


FIG. 27.

plugging is carried up the entire height of partition and walls, serving the purpose of deadening, as well as a fire-stop.

89. Pockets for Hot-Air Ducts.—The plans show the position of all hot-air ducts running through partitions, and as the dimensions of each are marked on the plans, the spacing of the studs forming the pocket for them is a very simple matter to determine; the superintendent, however, should take particular notice that no timbers are in the way, and if

such a condition exists, he should exercise his judgment in shifting the location of the ducts if necessary to avoid cutting the timbers. These remarks may also apply to the location of other service lines in the partitions. The superintendent should also see that the joints in the hot-air ducts are properly fitted and that the air space required is left around them and that the woodwork on all sides of the ducts is protected with tin, having the joints well fitted together, twined around the timber, and tacked down. It is better to carry the ducts up through closets where such a thing is possible.

Of the plumbing work, none but the rough work or that of setting the service lines in place need be done. The superintendence of this work, with a special regard to the quality of the materials and workmanship, will be explained later; but at this time their position should be looked after, with reference to running through partitions, to make sure that no hubs or connection will appear beyond the finished plaster, and that no timbers are cut by the plumber, who, according to the specifications, is required to notify the carpenter when such cutting is necessary.

In putting in gas and water supply pipes, the same precautions should be taken to prevent cutting the floor timbers anywhere beyond a point 2 feet from the bearings, and as a $1\frac{1}{4}$-inch under floor is laid over the joists, the running lines may be put in and the floor butted against them.

The superintendent should see that the conduits for electric wiring are put in at the proper places, that the main group of risers is placed in an accessible position, and that suitable support is provided for the metal clips used to secure the conduits, and, in setting junction boxes and terminal outlets, that they are in the proper position before any lathing or plastering is done. The general inspection of this work is fully explained under the heading Electrical Work.

The setting in place of speaking tubes should also be followed to see that the proper number are put in, that the joints are well fitted together, and that they are placed in a position to preclude the possibility of being injured during

the progress of the work to follow; they should also be properly secured with metal straps or clips, not staples, and the height and position of the outlets should be checked so that no alteration will be necessary afterwards.

90. Roof Construction.—While the foregoing work of setting plumbing, supply, and waste lines, etc. is being carried on, the outside finish of the building is rapidly progressing; the laying of the shingles on the roof being especially hurried so that when the lathing is completed the plastering may be started without unnecessary delay. The boards forming the bottom of the roof gutters should be graded to the leader outlets; rough unplaned boards being suitable for this work, as the copper lining will cover them. The boards should be closely fitted and well nailed in place, and the false rafter ends, which act as brackets to carry

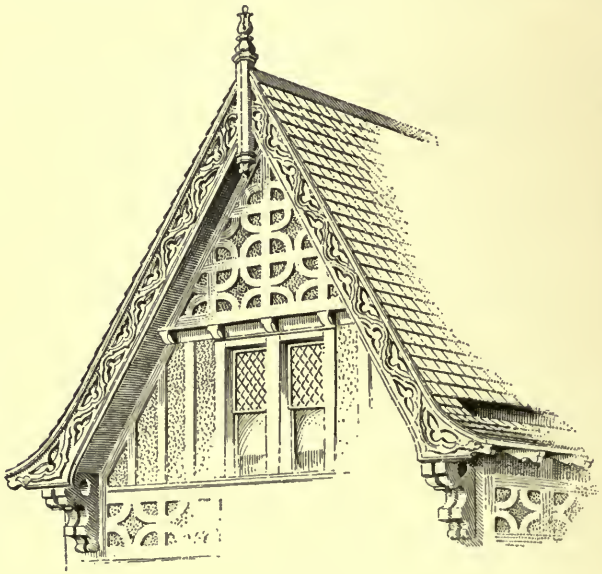


FIG. 28.

the projecting eaves, should be well spiked to the framing and set in perfect alinement. The gutters being ready, the barge boards are set in place, as shown in Fig. 28.

A $1\frac{1}{4}'' \times 9''$ board is laid along the eaves, valleys, and hips of all roofs to form a good foundation for the copper flashing and covering. While the $1\frac{1}{4}'' \times 3''$ shingle lath are laid and spaced 5 inches on centers, the framing of the veranda, porte cochère, and roof of the belvidere, the setting of the window frames and plaster grounds, the cross-furring of ceilings and first-story walls, the carrying up of the chimneys, as well as similar work on the stable, are all in progress simultaneously.

91. Shingles.—The laying of shingles or slates (in this case shingles) begins at the gutter with a double row, set to a line and having a projection of at least 1 inch over the stop mold on the back lining. The gauge or weather of the shingles are marked off to the top of the roof as the courses are laid, a chalk line being used for the purpose. The specifications require that, "All shingles for covering of roofs on the premises shall be of braced-sawed cedar shingles, 18 inches long and not less than 3 inches wide, secured with at least two 4d. galvanized-steel wire nails, the shingles to be dipped one-half their length in Cabot's creosote shingle stain of an approved tint," and stacked up until dry before being laid.

Although the brand of shingles specified should be sufficient, it would be well for the superintendent to inspect them. The shingles should be entirely free from knots, cross-grain, and of approximately uniform width. The wider shingles should be reserved for finishing hips and valleys where cutting is necessary.

Felt paper is sometimes used for underlaying the shingles, but cannot be recommended; it may be for slates, however, for, where they are exposed, as in an unfinished attic, the warm air of the building will condense on the cold surface of the slate and possibly cause considerable damage to the plastering of the rooms below. Snow guards made of copper wire are inserted at intervals of 1 foot in each course on the main roof, as the roof pitches are steep.

The specifications require that all leaders shall be rectangular in section, with their sides crimped or corrugated,

and of the requisite sizes, as shown. The detail drawings were furnished for the leader heads and wrought-copper straps, and the superintendent should see that the details have been followed, and that all are properly connected with the gutters of the buildings, secured to the building with the straps described above, set perfectly plumb, and connected with the drainage system, described in Art. **111.** Provision should be made to carry off rain water temporarily, until the copper conductors are set in position, which is done after the second coat of paint has been applied to the exterior of the building.

92. Window and Door Frames.—In setting the window and door frames in masonry openings, the rough projecting mortar should be cleaned down, the check in the masonry jamb coated with about $\frac{1}{2}$ inch of strong cement mortar (Vicat cement against the stone facing), and then the stonework set in, leveled and plumbed, and secured in place. The superintendent should see that the space between the joint and frame is well filled with mortar so that no space will be left for the wind or rain to blow through; he should also see that the sills of all frames, immediately after being set, are covered with a rough board to protect them from injury caused by hauling timber over them, or otherwise, until the time arrives for painting them.

93. Furring.—Very little attention is required of the superintendent in inspecting this work. The principal points which he should attend to are, that good sound stock of the requisite size is used, that the furring is well nailed to the bearings, and that it is spaced at the proper intervals—the specifications requiring them to be set at 12-inch centers. The furring on the masonry walls in the first story is to be set vertically at the same distance on centers, and the superintendent should see that no wooden plugs are driven into the joints for the purpose of holding the nails; such plugs would be necessary in furring off a very rough rubble masonry wall, but are unnecessary in this instance; the backing being of brick, offers a fairly smooth surface to nail to. At least

12d. nails should be used for this furring, and the strips should be in one piece from floor to ceiling, nailed at frequent intervals. All vertical furring should be plumbed and lined up, to insure a perfectly even and smooth surface where the plastering is finished. Blocks of wood may occasionally be necessary, and, if so, suitable pieces (not "chips") should be used.

94. Grounds and Lathing.—The setting of grounds is also a comparatively easy task when the furring and partitions have been properly set and lined up; the thickness should be looked after, however, as that determines the thickness of the plaster to be put on; their nailing should be well done also, for a loose piece is liable to pull the plaster away from the laths.

Metal or wire lath is undoubtedly the best under all circumstances and should be used when small extra expense

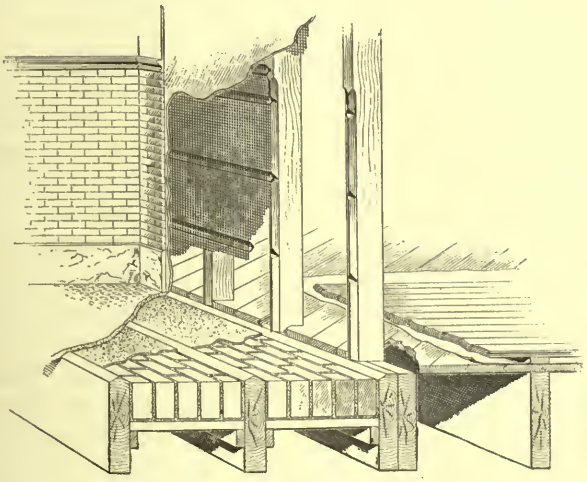


FIG. 29.

is not a consideration. The specifications require that galvanized-iron wire cloth, of No. 12 gauge, with $\frac{1}{2}$-inch ribs, is to be used for plastering throughout the interior of the building, with the exception of the vestibule and bathrooms, which will be lathed with wood lath secured with copper

nails. The wire cloth is supplied by **V**-shaped pieces spaced at intervals of about 8 inches and woven into it. See Fig. 29. These pieces keep the lath away from the studs so that the plaster has a good key at all points. The superintendent should see that this wire lath is nailed to every bearing and that the nails are driven up tight and not partly set in, also that the joints are broken and the cloth lapped at least 1 inch; he should also see that the lathing on the ceiling is carried back to the chimneys, and not stopped against the face of the furring around them.

When wood laths are used, the superintendent should see that they are as specified: sound, free from knots, sap, or bark edges, of a uniform thickness, and spaced not over $\frac{1}{4}$ inch apart for patent plaster, such as King's Windsor cement or Adamant wall plaster, and for ordinary mortar from $\frac{1}{4}$ to $\frac{3}{8}$ inch apart. For the best work it is required to break joints at every course, but for good ordinary work the joints should be broken every sixth or eighth course.

If the laths are too near together, the mortar will not be sufficiently pressed into the joints, and will not key. On the contrary, if the laths are too far apart, and the mortar is quite soft, it will drop off from its own weight. Care should be taken to see that the laths are nailed to every bearing, that no laths are allowed to fall short of the bearing at the ends, and that no thin or imperfect laths are used in any case; if such work as that just described is allowed to pass, the plaster is liable to crack and fall off when pressed upon or struck with a hammer in putting up trim, etc. In laying laths from one side of a room to another, it very often happens that a narrow space is left, and this space will generally be covered with laths set vertically, for the sole purpose of simplifying the work; this should not be allowed, as cracks will surely appear on the line formed by the change of direction of the laths. In a very narrow space, say 4 to 6 inches wide, the laths may be put on diagonally, and should be cut on the ends with a hatchet to obtain a good bearing for the nails. Any wood lath split in nailing should be removed and replaced by a sound piece.

SUPERINTENDENCE OF THE PLASTERING.

95. Temporary Heating.—If the plastering is to be done during freezing weather, provision should be made to have temporary heat to facilitate the drying of the mortar.

If the building is to be heated by steam, hot water, or hot air, the heating contractor should furnish, set up, and connect in each room temporary radiators or registers of a size requisite to heat the rooms to a normal temperature of 70 degrees; the owner agreeing to pay the heating contractor, over and above the contract price, about $3.00 for each radiator or register, the owner maintaining a competent man to operate the heating plant, and furnishing all necessary fuel, oil, etc. during the required period agreed upon between himself and the heating contractor.

In small country dwellings with no regular heating system, stoves or fire-pots are employed for the purpose of drying mortar, but this method of forced drying is objectionable. Of the two methods, that with fire-pots is undoubtedly the better, but, if used, the pots should be set in boxes filled with sand, situated in the center of the room. The fire-pot should be taken out into the open air when the fire is started, as the smoke from the burning wood will discolor the walls and cover them with a greasy film of soot. After the wood has burned sufficiently to ignite the coal or coke and has ceased to give off smoke, the fire-pot may be brought into the building and deposited in the box of sand. The fire-pot and method of carrying it are shown in Fig. 30. A man should be kept in constant attendance on these fires, and the expense so incurred, as well as that of furnishing fuel, should be paid for by the owner, unless otherwise provided for in the specifications or agreed upon between the owner and the contractor.

FIG. 30.

96. Plastering Mortar.—The mortar to be used for the scratch and brown coats of plaster should be mixed at least a week before the lathing is started, and stacked in the rough until the time arrives for using it in the building. This enables the lime to slake thoroughly, so that when it is tempered for use by reworking the result will be a fine homogeneous mass. The mortar should be mixed in the open air, and in winter should be protected from rain, snow, and frost; it should never be mixed in the cellar, as the moisture of the mortar will cause the floor joists and other timbers to swell.

While the mortar is being mixed the superintendent should see that the proper lime and sand are used; the lime should be well burned and slaked thoroughly when covered with water. If underburnt lime is used, "cores," or imperfectly burned pieces of lime, will be scattered throughout the mass and may not slake until after the mortar is applied to the walls, causing what are known as "chip cracks," or "blisters." The sand should be inspected to make sure that it is clean and contains no clay either in lumps or loose.

The superintendent should see that the mortar contains the requisite amount of hair, and that in applying it to the walls, sufficient force is applied to secure strong clinches, or, in other words, that the mortar is squeezed through the joints between the laths so as to bend over on the inside. It is very important, especially in two-coat work, to see that the brown coat is well leveled up and true to a line on all angles and corners, for the white finishing, or skim coat, is merely a thin veneer of plaster and cannot be depended on for truing up the wall surfaces. The scratch coat should be leveled up, trued in the angles, and if three-coat work is called for, scratched to rough surface with a wooden comb of pointed laths nailed together in a row.

97. Screeds.—After the scratch coat has set hard, *screeds*, or strips of mortar, as explained in *Masonry*, § 8, should be run along all margins and down the angles or corners; a long straightedge is applied and the screeds are

worked until a perfectly true surface is obtained; intermediate screeds are put in, especially on large surfaces, the number, of course, depending on the length of the straightedge. For the best work, a spirit level is applied to the straightedge, and by this means a perfect job will result. After the screeds are sufficiently dry, the body of the brown coat is filled in and worked to the plane of the screeds. The screeds in all corners and on angles should be plumbed. In rooms having a plaster cornice, the brown mortar should be scored to a rough surface along the margin of the ceiling and side walls to afford a good key for the extra weight of plaster; at this point it should be observed that both brown coats are carried down to the floor.

98. Bracketing.—If a heavy cornice is to be put on, wood or metal bracketing or cradling, of the same general outline as the cornice, should be provided, and set up. If wood brackets are used, as at *a*, Fig. 31, a strip *b* is first

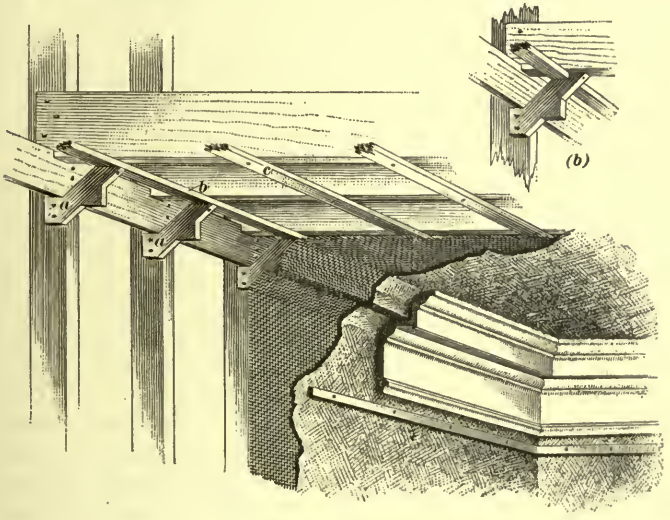


FIG. 31.

nailed along the floor joists above, and the brackets are set to it, in that way getting them in a straight line; a cord stretched

across the studs is sufficient to bring the bottom of them into alinement. This strip is put on only where the ceiling is to be cross-furred with the furring strips *c*, and if no furring strips are to be used on the ceiling, the brackets are notched over *b*, as shown at (*b*), or the strip *b* may be omitted entirely. In the setting of cradling and all such work, the superintendent should see that sound lumber is used, that all are set to a true line and well nailed in place. In shaping the rough brackets just described, it should be borne in mind that at no point should the plaster be thicker than 1 inch, except perhaps on acute angles or some such position where it is unavoidable.

99. White Finishing.—After the plaster cornices are finished, the white finishing or "skim coat" is applied. This consists of pure lime, which should be slaked, strained through a fine sieve to remove any grit or unslaked particles of lime, and allowed to stand in a covered trough or in barrels for at least a week before it is used. After standing for a few days, the hydrated lime should be of the consistency of white lead, or firm enough to be carried on a shovel. Washed sea sand and water are then added by the helper, who tempers the mixture to a soft paste. It is supplied to the plasterers in this form and they mix it on the mortar board with plaster of Paris and water, tempering it until reduced to the required consistency. In using this plaster a good workman will exercise great care that all his tools and mortar board are thoroughly clean; but sometimes a careless man will use a rusty trowel, or perhaps the helper will fill his hod with a shovel that has been used for some other purpose. The superintendent should follow this work carefully to see that the plaster is properly applied and skimmed in a manner to hide all brown mortar, scratching down all uneven surfaces of the brown coat, if necessary. He should also see that no iron nails or other metal work that is likely to rust is left in a position to discolor the plaster, as the white skim coat should show a perfectly smooth and unblemished surface at completion. Another and a very important point to

be looked after by the superintendent is that of fires, if the plastering is being done in cold weather; particular care should be taken with the fires while the white finishing coat is damp, for any dust arising from shaking or poking the fires is sure to settle on the walls and do irreparable damage. The fires should be kept as nearly in the center of the room as possible, for if brought too near the wall, the white finishing coat will dry out too quickly, and in doing so the plaster will crack into innumerable shapes and present an appearance similar to alligator hide.

100. Brackets and Centers.—In setting plaster brackets, care should be taken that they are set at the proper height above the floor and that they are plumb to the wall surface. In setting centers, the superintendent should see that they are in the center of the ceiling, which, of course, is previously found by the gas-fitter and checked by the superintendent. It is a comparatively easy matter to find the center of a room, and, although very easily done, is often neglected or carelessly done by gas-fitters and plasterers. The intersection of two strings stretched from the corners of the room and crossing it diagonally will mark the center. Where improved or patent plasters are specified, as in this case, the specifications requiring that the bathrooms and vestibule shall be finished with (King's Windsor cement), the superintendent will only be required to see that the proper materials are used and that they are mixed strictly according to the instructions of the manufacturers. In general, the superintendent should prevent, as far as possible, the use of reworked mortar, or mortar that has become partly set.

101. External Plastering.—Many methods are employed in mixing rough cast and mortar for external plastering and also the manner of preparing the wall surfaces, differing according to locality or custom. A method employed in Canada and in some of the states bordering on the Great Lakes consists of sheathing the frame with matched boards as for ordinary clap boarding, laying over this a layer of tarred paper or other similar material; the

laths are put on diagonally, spaced about 1½ inches apart and well nailed, after which a second layer of laths is put on in the opposite direction and also well nailed, as shown in Fig. 32. A coat of lime mortar, well haired, is now put on and scratched to a rough surface to form a key for the second coat; a second coat of lime mortar is put on after the first has dried out and the work is finished by the application of the rough cast, which consists of screened gravel mixed with strong lime and water to a thick fluid, which is dashed on with a small wooden float. The surface is made comparatively smooth with a brush which is dipped in the liquid, and by this means a uniform color is obtained.

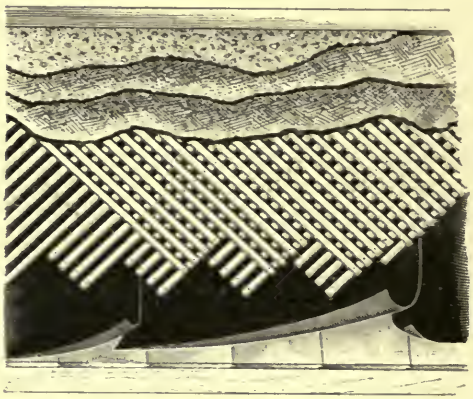


FIG. 32.

102. Composition and Color.—For the walls of the main building and the stable under consideration in this section, the external plastering is applied as shown in Fig. 33. Grounds are nailed direct to the sheathing lath of a thickness to correspond to the thickness of the plaster. The first coat consists of sharp sand, lime, Portland cement, with an admixture of cattle hair, applied with good pressure to fill the grooves in the

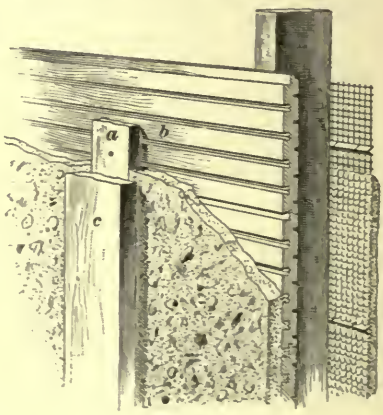


FIG. 33.

sheathing lath; this coat is scratched to a rough surface and allowed to dry. The second coat of mortar is the same as that used for the first coat except that the hair is omitted; this coat is troweled down to a smooth surface. The last coat, called the *rough cast* or *dash*, is mixed and applied in the same manner as in Canadian practice, previously described. This coat is necessarily thin and should finish flush with the grounds, that the open timber staves or battens may be put on without unnecessary scraping of the plaster surface. The dash coat may be colored any desired tint by the admixture of mortar colors. Care should be taken, however, in the selection of these colors, for Venetian red and some other earthy colors fade in a short time and present a dingy or sickly appearance. Metallic oxide and copperas green are permanent colors, and when mixed with lampblack in different proportions a variety of tints may be obtained. It should be remembered that colored mortar does not dry out the same tint as it shows while in a liquid state, and before the amount of color to be used is decided on, several samples should be mixed up and allowed to dry, in that way determining the amount of color to use.

For the inspection of this work, the same general suggestions as those given for inside plastering will apply, and any further remarks are perhaps unnecessary.

SUPERINTENDENCE OF THE BRICKWORK.

103. Chimney Breasts.—The chimney breasts in the kitchen and laundry are to be faced with white enameled brick; a segmental brick arch is turned over the opening, and the springing line is at a point 5 feet 6 inches above the finished floor. The jamb corners are rectangular and the corners around the opening are rounded, or "bull nose," and a polished white-marble corbel on each side supports a 3-inch polished marble shelf. The enameled brickwork in the laundry is carried up 5 feet high and finished with a

polished white-marble lintel 9 inches high, having a 4-inch beaming on the beds and anchored to the body of the chimney with bronze anchors. The superintendent should inspect this work carefully, to see that the face brick is properly laid and bonded, that the joints are all uniform in thickness, that the marble corbels are properly set, anchored to the chimney, and leveled up to receive the shelf, and that a perfectly tight joint is made between the brick and the range so that no cracks or openings are left to collect dirt or harbor vermin; he should also take particular notice that no damaged or chipped brick is used in this work.

The size of the flues is determined beforehand and shown on the drawings, so that the superintendent need only see that they are built to the requisite size, carried up plumb, and the withes, shown at *a*, Fig. 12, are mitered with the stretchers at least in every sixth course. It is not an easy matter to watch this work, as, in order to see that it is done, the superintendent would have to stand over the men constantly; he must therefore trust to the honesty of the workmen, as no evidence of the bonding will appear on the surface of the chimney. The fireplaces, which are to be faced with tile, are formed roughly during the construction of the chimneys; those faced with brick are finished at once, and the face brick is protected, with boards or otherwise, until it is required to set the mantels.

Two wrought-iron bars, $\frac{1}{2}$ in. $\times 2$ in., turned up on the ends, are built in each chimney above the fireplace opening, as no reliance should be placed on the arch to support the work above. The splay of jambs should be determined by the style and size of grate, if any is to be used, and if no grate is used the splay may vary, but should never be more than 8 inches in a depth of 12 inches. The back of the fireplace should be built up plumb six or eight courses, and then corbeled forward to form the throat from 2 to 4 inches wide, according to the nature of fuel used and the size of the fireplace. No matter how well built the chimney may be, all should be plastered on the outside, except where faced with a good coat of lime and cement mortar, to

prevent the possible escape of sparks through a defective or improperly filled joint.

104. Chimneys.—The brick courses in the chimneys at the roof line are to be stepped as shown on the detail drawings; the mason shall procure from the coppersmith the apron flashings and build them into the work. The chimneys above the flashing lines are to be built of rough-pointed limestone, well bonded together at each course with bronze cramps; the flue linings to be carried up and the space between them and the chimney filled with Vicat cement. The chimney caps are to be cut in one piece, and the flue holes cut through to exactly the same size as the inside of the flue lining. The superintendent should inspect every piece of ashlar entering into this work, and see that they conform to the specifications in every respect, especially as to thickness, and that they are all cramped and bonded together. The tall chimneys are to be tied back to the roof with 1-inch brass bars, having a nut and washer on the inside and a shoulder welded on to the outside against the chimney; the other end of the rod is flattened and turned up to conform to the angle of the roof, to which it is secured with wrought-iron bolts; these bolts should be put up at the proper time and the roof end covered with lead flashing.

105. Trap Pits.—Trap pits are to be built for the reception of service-pipe fittings, such as valves, traps, etc., that such fittings may be accessible should it be required to disconnect any pipe or make repairs. Footing stones, 2 feet wide and 6 inches thick, are laid at the required depth, and the walls built 8 inches thick, of common brick, laid in Portland cement mortar. The dimensions are given on the working drawings and the superintendent should see that they are built to the proper dimension and levels and located as required. The laying of the brick and the concrete bottom should be watched, that a water-tight job will result; the setting of the flagstone covers is described under "Flagging."

The main lines of sewer and water and gas supply should

all be laid underground at the proper grade, and the traps, fresh-air inlets, etc. on the sewer, and all valves and connections, attached complete. These pipes should then be tested before the trenches are filled in. The electric conduits are then laid at a uniform depth of about 3 feet below the surface—the mason meanwhile building up the manholes—and the electric feed wires having been laid between the manholes, the space around each pipe and conduit in the brick walls is sealed with neat Portland cement mortar. Provision should be made for a controlling switch on the main electric feed wire. The specifications require that all iron pipe and fittings in the manholes shall be cleaned off and coated with

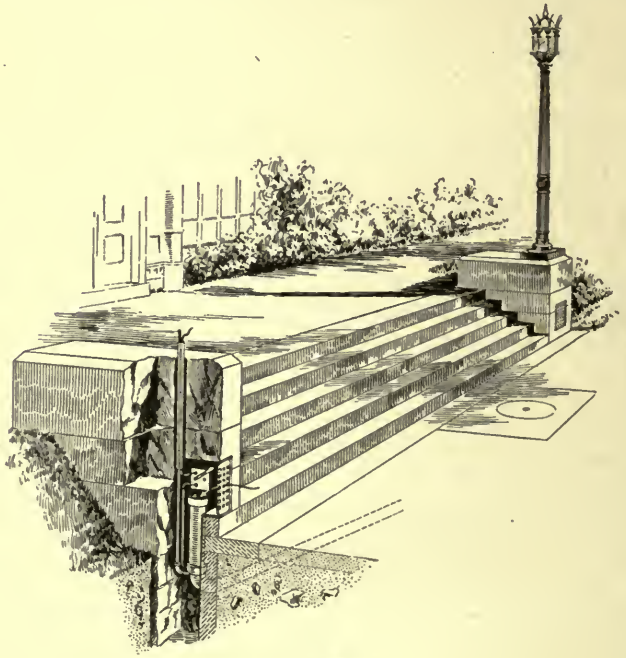


FIG. 34.

asphalt paint. Nothing need be added here to the instructions for inspecting the calking of joints and the quality of the fittings. The fresh-air inlet to the trap on the sewer main at the manhole at the entrance gate is to have offsets

with obtuse-angled bends, and the pipe terminates at a point 12 inches above grade, and in the pocket cut in the cheek block of the gate post. The gas and electric supply for the lamp also passes through this pocket, the opening in the stonework being covered by a perforated brass plate, set flush with the face of the stonework, as shown in Fig. 34.

SUPERINTENDENCE OF THE PLUMBING, ETC.

106. Pipes. — The next work of importance on the premises, and, in fact, the work requiring the most critical supervision in regard to material and workmanship, is that of putting in the branch waste, vent, and supply pipes from the rising lines to the various fittings.

The lead pipes should be inspected to make sure that they are of the proper weight per foot. The end of each coil is generally stamped with a letter or number denoting the weight; for that reason it is best to inspect the pipe before it is cut for use.

It is a well known fact that water containing certain foreign matter, and especially soft water, will attack lead pipe, and if the water is under heavy pressure there is a possibility of the pipe bursting, unless of extra thickness. Where a first-class job is the main object in view, it is best to use seamless drawn brass tubing, tinned inside and out, the cost over that of lead pipe being very slight. In the case under consideration, the main water-supply pipe to the under side of the first-story floor of the main building and up to the fixtures at other points on the premises, including hot-water piping, shall be of tinned seamless brass pipes of the diameter specified; all the fittings for the supply pipes to be of the same material and finish as the pipes.

The superintendent should examine all the material critically and follow the work of fitting it together, that the joints are set in *red lead*, provided with all the valves and fittings requisite, and graded to an outlet as specified. Where brass or copper piping without an outer plating

of some other metal is used, it should be coated with shellac to prevent discoloration, which is sure to occur unless some preventive is applied. Wrought-iron pipe is used extensively and various coatings of more or less merit are applied, such as ordinary lead-oxide paint, enamel or asphalt paint, and metal plating. Galvanized-iron pipe is perhaps the most common, and is undoubtedly the best for water pipes that are not liable to be attacked by water containing acids.

107. Leaks.—In the best work provision is made for carrying off water from leaky joints, possible bursts in the pipes, or water of condensation. A casing or tube of sheet metal, generally of zinc or light sheet copper, is used; the joints of the tubing are fitted together around the pipe fittings, and the tubing discharges into a sink or connects with the regular drainage system. The importance of putting in this casing is evident, for a leak under the floor, or in some inaccessible position, may cause more damage to frescoes or other decoration than the original cost of the tubing itself.

It is perhaps hardly necessary to say that none other than the most skilled mechanics should be allowed to do the work of plumbing and gas-fitting, for no other work on the whole job can be so easily skimped or improperly done, when the superintendent is not constantly on hand; and as he will have many other things to attend to on the premises, it is imperative that skilled, as well as honest, conscientious workmen are commissioned to do the work.

There is no doubt that the superintendent under ordinary circumstances will have to rely on the honesty of the workmen, but he should devote all attention possible to see that the proper fittings are put in, that they are properly connected, and that the lines are properly spaced apart and supported by straps, hooks, or tacks, as the case may be, governed, of course, by the specification, which should be very explicit in regard to the plumbing work.

The plumber should give due notice to the carpenter to put in boards for the support of running lines of pipes between joists, finished pipe boards where exposed to view,

and for all cutting of timbers or other woodwork in and about the premises, etc.

108. Joints in Cast-Iron Pipes.—All joints between lead waste or vent pipes and cast-iron pipes should be made with heavy brass ferrules calked into the hub of the iron pipe and secured to the lead pipe by means of a wiped solder joint. In common practice the lead pipe is simply dressed down and fitted in the end of the ferrule, as at (*a*), Fig. 35,

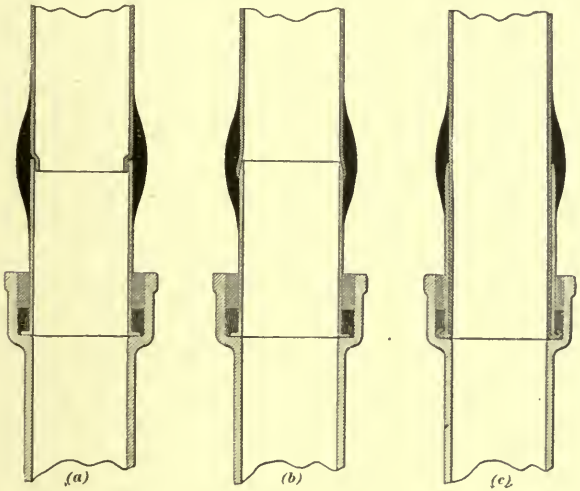


FIG. 35.

or slightly flared, as at (*b*), the latter being perhaps the better of the two, though there are objections to both methods, as the molten solder is likely to work into the joint and act as an obstruction for solid matter to accumulate against. The best method is to use a ferrule just large enough to allow the lead pipe to be slipped through it, as shown at (*c*), and then secured by the wiped solder joint.

At the point where the soil and vent pipes pass through the roof, the top of the hub should be located a little above the roof. A piece of 6-pound sheet lead, or of copper, at least a foot square, is dressed down into the hub of the pipe, and, after the length above the roof is set up, the joint is

calked tight with oakum and molten lead, as previously described.

109. Grease Traps.—In the use of kitchen and pantry sinks, a great deal of grease and such matter passes off with the waste water, if hot water is used; this fatty matter is in the form of small globules, which will harden as soon as they meet cold water or air. These small particles soon accumulate on the inside of the waste pipe, and if there is any obstruction to the flow of water, the pipe is liable to become choked and the services of a plumber will be required. To obviate this, various forms of grease traps are placed on waste-pipe systems. The trap known as a chilling-grease trap is, however, the best for the purpose. One of these traps, connected with the waste pipe from the kitchen and pantry sink, will be found of great value and will amply repay the first cost of instalment. These traps will be found very valuable under wash trays also, or in a position where a great deal of grease or fatty matter passes through them; one trap for a set of three trays is generally sufficient.

110. Water Closets.—In first-class work the object always kept in view is to have "open plumbing work"; that is, an arrangement whereby all fixtures and fittings above the floor are in full view and readily accessible. No cased-in fixtures should be allowed where good plumbing is required.

The setting of water closets should be very carefully watched, that there will be no chance for the escape of gas. Brass floor flanges are used for the best work, and by means of these the plates; fitting closely together, bolted up, and set in red lead, make an absolutely gas and water tight connection between the bowl and its outlet. The outlet pipe for these closets generally consists of a short bend of heavy lead pipe, 4 inches in diameter, which in turn is connected by a wiped solder joint to a brass ferrule and the ferrule calked into the hub of the Y-branch connection.

The superintendent should see that the supply and back air connections on the closet bowl are of brass, and not the

old fashioned crockery "horns," which are liable to break off and, at the best, are of very little value, as nothing but putty or some such material can be used for making the joint.

111. System.—All offsets and branches in the waste and vent lines throughout are to be made with obtuse-angled bends and Y branches; all running lines, whether of iron, brass, or lead, and also all service pipes for water and gas, are to be graded, that they may be drained when so desired.

The first floor, second floor, and attic are each to have a separate rising line of gas and water supply controlled by a stop-cock in the cellar. Connections are to be made in the cellar for hydrants about the premises, for water supply to the heating apparatus, and for faucets in the cellar, and each is to be independent of the other, controlled by a separate stop-cock. The make and quality of all stop-cocks, faucets, valves, and connections being covered by the specifications, the superintendent will determine whether the proper materials have been furnished, that the system is properly arranged to give direct and efficient service, and that the workmanship is up to the standard required by the specifications.

112. Tests.—As soon as the waste and vent pipes with their traps and connections are in position, and before any fixtures are set up, all openings must be closed up; in lead pipes the ends are merely pinched together and soldered, and the openings in iron pipes are closed by means of plugs, screw clamps, or some such device. Many methods are employed to test the system; the peppermint test used to be the most common, but is now rapidly being abandoned. This test consists of filling the traps with water and then pouring a quantity of oil of peppermint into the pipe where it extends above the roof, followed by a quantity of hot water, after which the roof opening is sealed and the inspection of the lines commenced. If the odor of peppermint can be detected anywhere about the building, the plumber will

have to search until the leak or leaks are located, and after making repairs or putting in a new length of pipe or a fitting, the same procedure has to be followed, very often necessitating two or three tests, before the work meets the approval of the superintendent, which, after all, may or may not be right. A simpler, and no doubt better, test is that of employing a testing machine in which smoke is the testing medium. Some such contrivance is to be found in every first-class plumber's shop. It is essentially a machine to blow smoke into the drainage system. Oily waste is used as a fuel, which, on being ignited, emits a dense, pungent smoke. This is blown into the piping system through stout rubber hose. The presence of a leaky or imperfectly calked joint, a sand hole, or a crack in the pipes or fittings is very readily detected by the smoke issuing from it. In this way the leak may be located at once and the trouble of going over the entire system, depending on smell to locate the defect, is avoided. The value of this method of testing is very readily seen. After the system has been tested to the superintendent's satisfaction, the work of setting up the fixtures, previously described, may follow.

113. Gas-Fitting.—The plumber is required by the specifications to apply for tapping the gas main in the street, and pay all necessary charges for putting in the service pipe and connections from the street main to the meter inside the cellar wall; the gas company to set this meter, as well as one in the greenhouse, and one in the stable, on cast-iron brackets furnished and set by the plumber. The same general directions for putting in gas pipes and meters applies also to similar work in the greenhouse and stable. The plumber's work on the gas-fitting commences at the meter, on the outlet, or house, side of which a lead pipe with brass coupling is provided. He connects the house main with this coupling and puts on a stop-cock as near the meter as practicable; there should also be a stop-cock on the inlet, or street, side of the meter. The method of jointing the pipes has been previously described. The location of outlets

for the several gas fixtures should be very carefully followed by the superintendent. The outlets in the principal rooms and halls, for side lights, should be from 5 ft. 6 in. to 5 ft. 9 in. above the floor, and for all other side lights 5 ft. above the floor. The nipples should be put on perpendicular to the wall surfaces. A piece of pipe about 3 or 4 feet in length, with a socket on one end, should be used for the purpose, and by screwing this pipe to the nipples, the outlets may be very easily squared. It is also very important that nipples of the proper length are used, so that they need not be changed or the terminal boxes taken off and replaced.

The fitting up of all gas-pipe branches for lights in the buildings, as well as for exterior lights, should be done simultaneously with the electric wiring for same, and in connection with the electricians.

114. Heating.—The specifications require that the indirect system of hot-water heating shall be used. The boiler is to be of a standard make and subjected to a hydrostatic test of 100 pounds to the square inch before leaving the factory. This apparatus is to have automatic feed and damper regulators, so that no engineer will be required. The battery of sectional heater coils and manifolds are supported on an angle-iron platform at the requisite height above the cellar floor. The specifications also require that perfect circulation be guaranteed and that the system shall be properly connected up and left in good working order. The heating flues are to be made of 18-gauge galvanized iron with closely riveted joints, and run as directly and with as few bends as possible to the registers. The registers are to be set in a metallic box and a suitable frame set in the side wall or the floor, as the case may be, provided with all necessary controlling dampers or regulators, and the perforated face plates set flush with the floor or wall surfaces, and finished in electro bronze, unless otherwise specified.

The superintendent should follow this work closely to see that it is carried out as required by the contract, that the joints in pipes and ducts are all properly fitted, and

connected up and all left in a perfect working condition at completion. He should see also that the cold-air ducts to the heater are of the requisite dimensions, run as direct as possible, and are provided with a damper at the cellar wall and one near the heater; that the openings to the cold-air ducts and the heating coils are protected by wire screens, as specified. He should require a very thorough test of the system in his presence and satisfy himself that the work is up to the requirements.

In regard to a time test, that is not possible under ordinary conditions, unless the heating system has been employed during the construction of the building; in any event, the contractor's guarantee, duly signed by him and given to the architect or owner, is generally sufficient; for in the event of failure of the system or any part of it to do its work properly, the contractor may be called upon to make good, at his own expense, all such work during the period covered by the guarantee.

SUPERINTENDENCE OF THE ELECTRICAL WORK.

115. Specifications, Etc.—The specifications require that the local electric-light company shall connect with the street main and lay the main feed wire to the trap pit in front of the greenhouse. All the work to be done strictly according to the rules and regulations of the National Board of Fire Underwriters, and is to be passed upon and made satisfactory to their inspectors as well as to the satisfaction of the building superintendent. The contractor to pay all charges for inspection by the aforesaid fire underwriters' inspectors and deliver a satisfactory certificate signed by them to the architect, including testing of the system. The carpenter will do all necessary cutting of timbers or other wood necessary to facilitate the installation of the electrical work.

The mains below grade are to be protected by heavy wooden tubing, having a 3-inch bore, the exterior of the pipe coated with waterproof paint, and the joists closely

fitted together. A main switchboard of polished slate and enclosed in a damp-proof box will be set up on the side wall of the trap pit, and from this board all the lights or other electrical fixtures on the premises will be controlled by four main-line knife switches, one each for the main building, greenhouse, and stable, and one for all the outside standard and gate lights. The lights of the first story and the porte-cochère light shall be controlled by a knife switch located at the rear of the main flight of stairs and each of the principal rooms shall have an independent key switch for direct control of the lights within the room. The second-story floor and the attic will each have an independent switch controlling all the lights on the floor, and the principal rooms of the second story, including the bathroom, shall have a direct key switch as provided for the first-story rooms. A separate key must be provided in the first and second story halls for the control of the automatic lights therein. Each of these main switches will be of an approved pattern and mounted on polished slate or marble in asbestos-lined boxes having a hinged door, the boxes to be provided and set in position by the carpenter, who shall also provide all blocking or other special woodwork required by the electricians. A cut-out box of slate will be placed in each trap pit at the entrance of the feed wire, another at the entrance of said wire on the inside wall of each building, and one hard-wood box lined with sheet asbestos on each upper floor of the main building and second story of the stable. A continuous system of conduits and wiring from the main to the outlets at the fixtures is required.

116. Installation.—All tubing is to be of brass, armored, insulated, and fitted together in a thorough manner to exclude gas and water, or other destructive agents. All mains are to run as direct as possible, so as to avoid sharp elbows. The tubes are to be of sufficient size to insure ease in drawing the wires through them. No conduit shall be less than $\frac{5}{16}$ inch inside diameter. Conduits are to be used for encasing all wires, including those for bells and

annunciators, and all are to be hidden from view in wall pockets or in larger tubes.

The risers for the main building, as well as those for the stable and greenhouse, are to be grouped together to form a single line for each building. The wires throughout for electric lighting are specified to be white-core, rubber-covered, insulated wire of copper 98 per cent. pure.

Carbon cylinder batteries are specified for the burglar-alarm system, for bells, and annunciators. They are to be of sufficient number and power to insure the proper working of the system named. Suitable shelves will be provided for their support and put in place by the carpenter.

The burners in the main halls and principal rooms in the first story are to be automatic; fixtures to be wired inside the shell where possible. All push plates are to be of plain bronze, finished to match the hardware of the room, and have pearl push buttons.

The wiring for the gas lighting to be of No. 18 gauge B. & S. damp-proof wires, put in without staples or tacks of any kind, and run through between timbers and in partitions. The wires must be protected by brass armored tubing against brickwork or pipes.

All lighting wires to be run in sections to an automatic sectional cut-out box where shown on drawings.

117. Fixtures.—The springs and plates required for all windows and doors in the burglar-alarm system, and all plates and mouthpieces for the annunciator and speaking tubes, are to match the hardware in each room and must be furnished to the carpenter, who will set them in position under the direction of the foreman electrician. The same applies to the annunciator box and burglar-alarm indicator box, the location of which is shown on the plans. Each of these boxes is to be provided with a nickel-plated gong; the bell for the annunciator to be $2\frac{1}{2}$ inches in diameter, and for the burglar-alarm indicator to be 4 inches in diameter. All are to be tested to establish satisfactorily their efficiency in presence of the superintendent.

The specifications require that at each outside door a push button and plate is to be placed, connected with a bell to be located as required.

The plate for the front door and rear hall outside door to be a combination mouthpiece and push-button plate of bronze, to match the hardware of the door.

The speaking tubes are to be of heavy weight bright tin, 1 inch in diameter, with a soldered seam, the joints to be well fitted together and the lines to run direct, with no sharp turns or elbows. Where elbows *are* necessary they are to be as gradual as possible. The mouthpieces are to be provided by the electrician and set in position by the carpenter.

118. Superintendence and Tests.—The superintendent should always be governed by the rules of the National Board of Fire Underwriters in passing on the work of electric installation, and in case of doubt, he should consult the duly authorized inspector of the underwriters' association before condemning any work, unless he is absolutely sure of his position in the matter. He should follow the work primarily with the view of having all conduits and service lines continuous and their insulation perfect. He should also see that the conduits, wires, and speaking tubes are protected from injury by water or otherwise, and that they are not otherwise injured by hooks, nails, etc.; after all of this work has been done the electrical system should be tested free from grounds.

SUPERINTENDENCE OF THE JOINERY.

119. Outbuildings.—While the plumbing and electrical work is being set up, much has been accomplished on the exterior of the main building, stable, and greenhouse. The rough-cast outside plastering has been done, the cornice, barge boards, and belt courses have been set in position, and the carpenters are busily engaged in finishing the joiner work on the veranda and porte cochère, and putting up the staves for the open timber work, which are put on as shown

in Fig. 33; the grounds *a* are put on over the sheathing lath *b*, and after the plastering is finished, the staves *c* are nailed to the face of the grounds. After the open timber work on both buildings has been completed, the finishing work on veranda and porte cochère set in position, and the work on the belvidere and summer pavilion completed, nothing remains to be done on the exterior of the buildings except the painting, which will be described at the proper time. On the interior of the building, workmen have started to put in the door frames and other interior finishing woodwork. This work from now on, although not as important as the construction part, will require strict attention on the part of the superintendent to see that no poor material is used, that no bad work is covered before he has seen and passed upon it, and also that all doors and standing trim are set plumb, all horizontal lines, such as wainscots, bases, etc., set perfectly level, and all joints neatly made and closely fitted together. He should visit the shop where the doors and other interior woodwork are being made, so as to satisfy himself that the proper amount of care and attention is given to minor details, such as building of cores for veneered doors, gluing up, wedging, mortising, etc.

120. Examination of Stock.—The stock should be examined for defects, such as sap, knots, etc., and any piece found that does not conform to the requirements, should be condemned at once. In regard to the dryness of the stock, if it does not appear to be thoroughly seasoned, and appears to contain more moisture than the limit prescribed by the specification—that is, 10 per cent. by weight—he should select a few samples, about 6 inches long, cut from the center of the board or molding; by weighing each piece carefully on any convenient scale, marking the exact weight on each sample, and then drying them out in an oven for three or four hours and weighing them immediately on the same scale, before they can absorb the moisture from the atmosphere to any extent, then noting the difference in weight, the percentage of moisture may be found *by dividing the difference between*

the two weights found by the dry weight. Thus, if a sample weighs 66 ounces at first and 60 ounces after being dried, the percentage of moisture contained in the sample before drying would then be $(66 - 60) \div 60 = 10\%$. Wood containing this amount of moisture or less would be accepted, provided, of course, it were up to the requirements in other respects. A percentage greater than ten, however, would be sufficient cause for condemning it, though it might be otherwise perfect.

Although, in general practice, the specifications simply state that the wood for interior trim shall be kiln dried, it does not necessarily follow that the wood is dry when erected in the building; for it is a well known fact that kiln-dried wood will absorb atmospheric moisture rapidly if exposed to the weather or stored in a damp situation, and the object to be attained by placing it in a kiln will have been defeated, the wood returning to a condition very little better than ordinary yard stock.

Rough framing lumber, however, or even finishing lumber to be used on the exterior of the building or where it is not likely to dry out rapidly, may be considered sufficiently seasoned when it contains as much as 15 per cent. of moisture. From the foregoing remarks it may be readily concluded that the best method of specifying finishing lumber is that of applying the weight test to determine the amount of moisture in it.

121. Finish of Surface.—Another part of the work which is sure to be carelessly done or neglected altogether is that of smoothing down the interior woodwork; this applies mainly to bases, trim, etc., as the shop-made work, such as doors, sash, wainscoting, etc., is generally smoothed off before being put together, or at least before leaving the shop.

Raised grain, planer marks, and soiled spots or finger marks from handling are the most common causes, requiring the work to be smoothed or sandpapered. Moldings with small members should be smoothed with sandpaper, while a smoothing plane should be used on flat surfaces and this followed by sandpaper. It is often best, especially when the

harder woods are smoothed down, to use a steel scraper or glass for the purpose; especially is this done where a shaggy knot or curly grain is encountered that may be injured even with the finest set smoothing plane.

122. Inspecting Work.—At this time the superintendent should read the specifications through, and if any work has been neglected or condemned work left standing, either unaltered or repaired, he should make a note of each and have them attended to before the time arrives for painting or otherwise finishing the interior. He should also compare all work with the detail drawings as it is erected or set in place, and allow no bad work to become too far advanced to be readily altered or taken down and replaced. He should see that the door jambs are blocked away from the stud framing, and that suitable blocks, sized for the position, and not chips, are used; that the jambs are set plumb, in alinement with the partition, and that the head casing is perfectly level. He should also check the size of the opening to make sure that a door of the proper size will be put in as required by the drawings. It is best to check the size of the finished openings at this stage of the work, for if a mistake is not discovered until later, the trim may have to be removed to remedy the fault, while the jambs are being set.

The swing of the doors should be determined unless they are shown on the plans, and even if they are shown, the workmen cannot always be depended on to set them in the right way. The superintendent should make sure that the doors are hung on the proper edge of the jamb, so that when hung and swung open they will not strike against a gas bracket or open across a hallway or into a closet. In general, doors should be hung to swing into the rooms and not out into halls or corridors, except perhaps outside doors, which should always open in, and in the case of bedrooms should be hung so that the bed is not visible when the door is partly open. The same idea should be borne in mind in hanging bathroom doors. Closet doors should be hung to swing into the room, and in a manner to reflect the light

from the inner side of the door into the closet, or else they should be hung so that the light from the windows may shine direct into the closet.

123. Trim.—The price of molding and interior trim varies according to the size, and when other than stock molding is required, an additional price to that of the molding itself will be charged for the labor of making a new knife and changing the cutters in the machine. Such moldings or trim are termed special, and add materially to the cost of the building, especially if a great variety is used. In ordinary low-cost dwellings, special moldings and trim are seldom used. The commonest forms of moldings that are recognized by architects and builders as "stock" moldings are shown in Fig. 36. (*a*) represents ogee crown moldings;

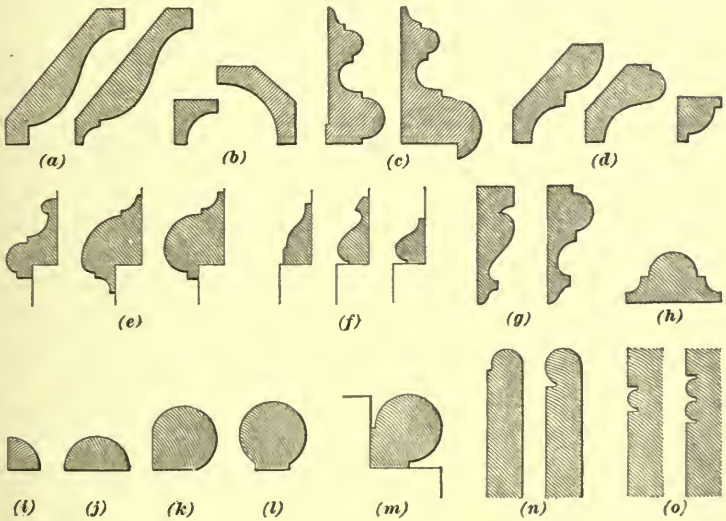


FIG. 36.

(*b*), coves; (*c*), base moldings; (*d*), bed or stop moldings; (*e*), raised panel moldings; (*f*), flush panel moldings; (*g*), band moldings, sometimes used as base moldings; (*h*), astragal; (*i*), quarter round; (*j*), half round; (*k*), three-quarter round; (*l*), full round; (*m*), three-quarter bead; (*n*), bead;

(*o*), single and double center beads. Other stock molds may be obtained, but those shown in the figure are most common.

124. "Finished" Size of Material.—The superintendent should know the "finished" size of material, that is, the size after being run through the planer; these remarks apply principally to moldings, as the piece from which the moldings are made lose $\frac{1}{8}$ inch in dressing both sides and $\frac{1}{16}$ inch more when run through the molding machine; a stock 1-inch molding, therefore, will measure only $\frac{13}{16}$ inch. The same may be said of finished boards or trim, as they are reduced in size in the planer, but charged for as though of full dimensions. Boards or plank surfaced one side will measure $\frac{1}{16}$ inch less, and when surfaced both sides $\frac{1}{8}$ inch less, than the sizes charged for.

125. Standing Trim.—The next work to be done after the jambs are set is that of putting in the *standing trim*, or finish, which consists of baseboards, wainscoting, architraves, etc. In putting in this work the superintendent should see that the baseboards and other trim have been painted on the back before they are set in position, to conform to the requirements of the specification, and in setting them to see that no bad joints are made, no moldings spliced, except on long horizontal runs, and that as few nails as possible are used on exposed surfaces of woodwork that are to be natural finished. In jointing the corners of back-band molded architraves, as specified for part of this building, and the mitered architraves in the stable and in the attic, the work should be watched to see that they are properly done. At (*a*), Fig. 37, is shown

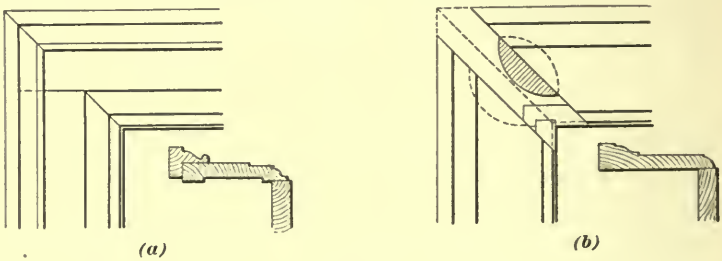


FIG. 37.

the proper way to joint a back-band trim of that particular form; the fillet mold should be mitered, the flat or facia section butt jointed, and the back band mitered. For a mitered trim, a hard-wood tongue or spline should be inserted as shown at (*b*), the grain of the spline running at right angles to the miter cut. The groove for the spline is cut in the shop or mill with a circular saw. A joint made in this way, if the wood is reasonably dry, will hold together well. Long, mitered joints, sometimes used in trimming around doors and windows, should be avoided as much as possible, as it is difficult to prevent the opening of the joint due to shrinkage of the material.

126. Stairs.—While the standing trim is being set in place, and before the wainscot is put in, the work on the stairs should be under way.

In general practice at the present day, the stairs are usually figured out for rise, tread, run, and headroom in the drafting room, drawn accurately on the plans, and this preliminary layout is generally supplemented by detail drawings. Stair building has become a distinct trade, and very few carpenters, except those in out-of-the-way places, build their own stairs, as the work can be done cheaper and better by men who follow that work entirely. Mistakes or poor workmanship, however, are always possible, and the work will have to be looked after by the superintendent with as much care and attention as any other. Very often a mistake is made in the framing of the well, the trimmer possibly being put in 6 inches or a foot too far for the sake of making it act as the trimmer for a chimney well. This slight difference in the location of the trimmer may reduce the headroom to such an extent, that a tall person will strike his head against it. To remedy a mistake of this kind will require much extra work and cause considerable delay.

The trimmer may have to be cut out, the flooring removed across the building, and a new trimmer, as well as a header, put in. When a mistake of this kind cannot be easily remedied, the architect may have to modify the design of

the stairs, and his ingenuity will be taxed to fit the work to the new condition. Counting from the head of the flight, thirteen risers will usually give sufficient headroom.

It is often necessary, especially in long flights, to reinforce the stringers with "carriage timbers," and these with the other timber framing of platforms and landings should be well framed and spiked together.

Winders in stairs are at the best a makeshift arrangement and should be avoided as much as possible. Of course stairs are often built in a position that necessitate the use of winders in order to reach the floor above by an easy ascent. In such cases, the winder treads on the line of travel should be the same width as the regular treads.

127. Stair Measurements.—The stair builder should verify all measurements at the building, the distance from floor to floor, especially as the heights of ceilings seldom measure exactly what they are figured on the drawings, varying from 1 to 2 inches either way. The stair builder measures off this height on a rod and divides it into spaces corresponding in number with the risers in the staircase. If the measurements given on the drawing for the height of stories is trusted, and the stringers cut to fit the height thus taken, a stairway resembling those shown in Fig. 38 may result.

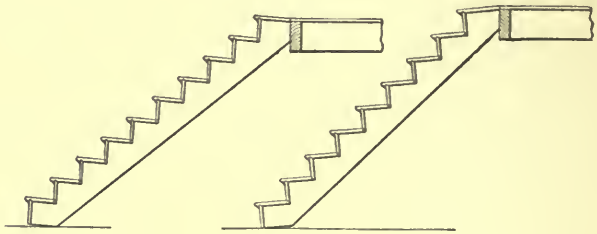


FIG. 38.

Another important point in laying out stairs is that of having all risers of a uniform height, for any change in height, although not apparent to the eye, will be discovered by traveling up or down; for instance, take a staircase having two runs, or flights, with a platform between, in which

the risers of the upper run are ½ inch higher than those below. Now if a person ascends this staircase rapidly he will be checked, as it were, as soon as he strikes the higher risers.

128. Points To Be Observed.—The wedging of the treads and risers, where they are housed into the stringers, should be looked after, as well as their mortising and tenoning. By having this work carefully done and paying especial attention to the quality and seasoning of the stock used, the stairway should hold for years, and be entirely free from any crunching of the treads. The dovetailing of the balusters should also be watched, to see that the cut runs through the tread and is not merely let into it, and also that the baluster fits the cut snugly, and is nailed in place to prevent its becoming loose. The setting of newel posts and rails should be carefully done, and care taken to have the newels plumb and square with the stringer, or set at the proper angle as required by the drawings; provision should be made for the placing of a half post to receive the end of the hand rail at its termination in the attic or elsewhere, for, if not called for, the stair builder may use a cast-iron or a wood socket. It should be seen that the balusters are matched in color, and that the rails, where they are jointed to ramps or easements, are well fitted, bolted together, and matched in color. Any piece of rail "out of wind" or not perfectly straight should be condemned. As soon as the staircases are built and the newels, rails, and balusters set, they must be protected from paint, plaster, etc. until the painter is ready to apply the wood filler or paint as the case may be.

Building paper, the full width of the stair, should be laid over treads and risers from floor to floor to protect them, and the paper secured in place with laths or light boards. A piece of this paper, or cloths, should be used to protect the rails and newels.

129. Preparing for Tiling.—The specifications require that the carpenter shall make preparation for the floor and wall tiling in the principal bathroom, for the tiling of the

vestibule floor and wainscot, and for the marble safe slabs in the servants' bathroom.

The carpenter prepares the floors as shown in Fig. 29 by first nailing cleats along the sides of the floor joists and over this tight matched boards; over the boards two courses of brick are laid in good cement mortar, the top of the brick to finish on a line with the top of joists, which are beveled on top to an edge. On the side walls the studs are beveled back $\frac{3}{4}$ inch, or a distance equivalent to the depth of the **V**-shaped stiffening bars on the wire lath, as shown in the cut; by this method no cleats are necessary on the side walls, but, if ordinary metal lath or wood lath were used instead, cleats would be necessary in order to afford a nailing for the laths, and very often pieces put in horizontally and spaced about 12 inches apart are required for the support of the lath; especially is this so when sheet-metal lath is used.

130. Laying Tile.—This does not properly come under the head of Joinery, but as the work is to be done by the mantel contractor, its superintendence would be considered at this stage of the work. When the interior finish is being set in place and after the rough part of the plumbing work has been set up, the mason should prepare the cement bed for the floor tile and the backing for the wainscot. The specifications require that the bed for the floor tile shall be laid by the mason with cement concrete and finished to a point $\frac{3}{4}$ inch below the level of the finished floor, and leveled up with Portland cement mortar. The first coat of mortar for the plaster backing in the side walls is made the same as the scratch coat for outside plastering. The second, or finishing, coat, which should be brought up flush with the grounds, is the same as the second coat for outside plastering. All these surfaces must be leveled up and brought to a smooth, uniform surface. This work completed, the tiler's work may start. The first operation consists in setting the marble safe slabs, which are furnished by the plumber; after these are set the floor tile should be laid, the marble base set, and the wainscot tile put on, all in the order given.

Portland cement and plaster of Paris are used in the setting of this work, and great care will be necessary to insure a first-class job. The superintendent's inspection on this work will be a comparatively easy matter; his attention should be directed mainly to see that the preparation for the tiling is properly done, the quality and kind of materials furnished and set as required by the specifications, and that the floor comes on a level with the finished floor in the hall and the wainscot on a line with the plaster above; also that the tile is laid so that no long joints appear, and that the joints themselves are of a uniform width.

131. Finished Floors.—Before the upper floor is laid, the superintendent should see that the rough floors throughout the building are cleared of all rubbish and swept out clean. The rough floor should then be repaired and patched around all plumbing pipe lines or elsewhere until no openings in the flooring appear anywhere.

A layer of Cabot's "deafening quilt" is laid over the entire first and second floors with a lap of at least 3 inches. Nailing strips are next laid and spaced at the same distance on centers as the floor joists. These pieces are leveled up until perfectly true. The floors of the various rooms in each story are to be as follows:

First story, main hall, quarter-sawed white oak, matched; second story, main hall, quarter-sawed white oak, matched; kitchen, clear maple, matched; laundry, clear maple, matched; pantry, clear maple, matched; rear hall, clear maple, matched; dining room, library, reception room, and parlor to have an upper floor of $\frac{7}{8}'' \times 4''$ white pine, matched, laid diagonally and at right angles to the rough underflooring, blind nailed, and tightly driven together and planed down, and a layer of sheathing paper laid down without lapping, to afford a smooth surface to receive the parquetry flooring, which will be furnished and laid by the mantel contractor.

132. The entire floor in the second story, with the exception of the main hall and bathroom previously described, to

be laid with $\frac{7}{8}'' \times 2''$ clear, matched, quartered or comb-grained Georgia pine driven together tightly and blind nailed. All the floors in the first and second stories to be planed down—which may be performed at an angle of 45° to the grain—scraped, and sandpapered, and then planed with the grain to a perfectly smooth surface. The butt joints in all floors, with the exception of parquetry floors, to be top nailed with two fine wire nails to each board and the nails set in well. The entire attic floor to be laid with $1\frac{1}{4}'' \times 3''$ clear, comb-grained, North Carolina pine, matched boards, blind nailed, and planed down in the hall and principal rooms.

The specifications require that all joints are to be made over bearings and break in every course. The boards around all hearths, registers, etc. are to miter on the corners, and to be rebated to fit the tongue of the flooring. The carpenter is to lay down two thicknesses of waterproof felt paper over all floors as soon as they are planed down and smoothed, and will be held responsible for the care of all floors, including the parquetry floors, until the painter starts the work of finishing them. The superintendent should see that all the flooring stock is uniform in quality and up to the requirements of the specifications; that neat joints are made. For finished or upper floors, a piece of wood somewhat thicker than the flooring as shown in Fig. 39 should be used for driving up the boards, and in that way the edges will not be injured by the hammer. The superintendent should see that the nails are not driven home with the hammer, but with a nail set. Clamps are often used in laying the finer grades of flooring for the purpose of straining it in place, and are sometimes necessary. If a floor board cannot be driven up easily it should not be used at all; for in driving, the tongue or groove may be split and break off at some future time.

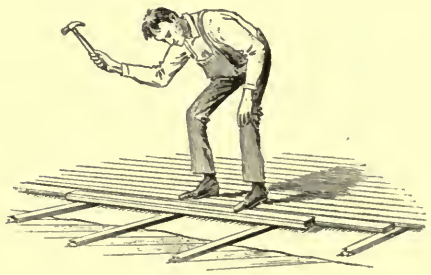


FIG. 39.

133. Blinds.—The specifications require that all sliding windows in the first story shall have hinged blinds to fold into a pocket formed into a window frame. The center fold in each side is to be provided with revolving slats and the side folds paneled. These blinds, together with the pocket lining, etc., shall be of wood to match the other trim in the several rooms.

The windows in the second story are to be provided with Venetian blinds, and the head casing will have to extend at least 8 inches above the head jambs of the window, so that when the blind is drawn up they will not obstruct the light. These blinds are made by several blind manufacturers who control patents covering them. After passing on the quality of the workmanship and materials, the superintendent should see that the blinds are properly hung and adjusted, so as to operate in a satisfactory manner.

134. Dressers, Etc.—As scale and full-sized detail drawings are furnished for pantry cupboards, kitchen dresser, wardrobes, etc., and all such furnishings of the various rooms, the work of the superintendent will be greatly simplified, and his attention need only be confined to the proper execution and erection of the work and to see that the drawings have been followed.

The pantry closets are built with a wide counter shelf $1\frac{1}{4}$ inches thick in pieces glued together. Below the counter shelf, drawers and cupboards are provided; one large drawer is divided for table linen, and another for knives, forks, spoons, etc. The specifications require that the bottom and inside of all drawers for table silverware shall be covered with black velvet well glued to the wood. These drawers, as well as all other drawers over 12 inches in width, shall be provided with ball-bearing slides, carefully put in, to insure perfect and noiseless working of the drawers. Provision is made to place a dust panel immediately under the drawers, for the purpose of catching dust that would otherwise enter the cupboards below. The cupboards below the counter shelf are to have doors hinged on the sides; the door to the

compartment for soiled linen to be hinged at the bottom with strong spring hinges and the top of the door provided with a spring latch. The kitchen dresser is to be built in a similar manner and provided with drawers and cupboards below the counter shelf. The doors of the closets above are to slide on a brass track and made to fit tightly. Sliding doors are preferable in such positions, as the hinged doors in swinging take up considerable room, the glass is likely to be broken, and the doors in shrinking, or warping, leave chinks or cracks through which dust can filter to settle on the china or other objects stored on the shelves.

The drip boards for the pantry and kitchen sink should be grooved for the purpose of draining them rapidly, and these boards should be set at a slight pitch toward the sink. The pipe boards previously mentioned should be neatly fitted against other woodwork and against floors, ceilings, etc., and set in place with screws. No provision has been made for wainscoting in the kitchen pantry or laundry; it is very objectionable in such positions, owing to the fact that food stuffs and water are known to attract vermin, and if the rooms are wainscoted, especially with ceiling boards, the spaces and cracks will offer a refuge for the vermin and render examination a very difficult matter.

135. Dumb Waiter.—The dumb waiter, although included in the general contract, is usually set in position by men skilled in that particular work. The framing and finishing of the shaft, including the doors and jambs, are done by the carpenters, and the car and its appurtenances put in position by the dumb-waiter men. This work should be followed carefully to see that the car is hung properly, the proper adjustment given to ropes and weights; that the sheaves, safety catches, and running mechanism are properly set in position; and that the car works smoothly and noiselessly. The testing of the ropes or car is not necessary here, as the specifications require that work to be done at the factory. The dumb-waiter shaft above the sheaves is effectually closed by a double matched-board platform with

two layers of deafening quilt between; the shaft above this point serves as a vent for the clothes chute and cupboards of the pantry closets.

136. Other Appurtenances.—A clothes chute is provided, extending from the housekeeper's closet on the second floor to the rear hall on the first floor, tight-fitting doors being provided at each end to prevent odors escaping from the contents. The chute terminates in a compartment under the pantry counter shelf, and a door hinged at the bottom in the pantry, previously described, opens into this compartment, so that all soiled linen may be kept in one place until it is taken to the laundry.

The mantels and hall seats are set in place by the mantel contractor, and the fitting of this work to that already in position is all that the superintendent will be required to look after. When the finished plaster chimney breast is wider than the mantel, extension pieces made to conform with the other work are provided.

The setting of the bookcases should be looked after to see that they are properly constructed according to details, well fitted to the wall, and that the shelves are set level and the doors properly glazed and hung.

At the proper time, the carpenter will furnish the painter with frames made according to details for the dressing-room mirrors, and after the mirrors are set in the frames, the carpenter will place them in position according to directions.

The setting of picture moldings should be looked after to see that they are perfectly level, and instead of trusting to the eye, they should be tested by measuring from the floor.

The superintendent should go over the work carefully and see that all the small details of construction or finish in and about the buildings have been attended to, examining each room in turn. Among other things, he should see that turned corner beads of wood to match that in adjacent doors or trim are put on all plastered corners requiring them; that all doors are properly fitted and hung, and all other

woodwork required by the electricians to protect or cover their work is set in position; and that all doors throughout are provided with strikes either screwed to the floor or baseboard, as he may direct.

HARDWARE.

137. Quality of Hardware.—As the hardware manufactured by different concerns varies greatly in quality, while the names of parts are the same, it is always best to specify the locks and other hardware of some manufacturer, giving his name and the catalogue name and number of the article, unless provision is made in the specifications, stipulating that the builder shall allow a certain amount for the finishing hardware, in which event the architect or owner may select the style of hardware desired. If either of these methods is adopted, mistakes will be avoided, and a uniform grade of goods obtained. As the specifications in this instance call for the hardware of one manufacturer with the catalogue name and number given, the superintendent need but see that the hardware specified is furnished, and this he may easily determine by providing himself with the catalogues or by a personal inspection of the goods at the manufacturer's warerooms. In addition to this he should see that all hardware of the finish specified for the several rooms is furnished. The locks on all principal doors should be placed at a uniform distance of 2 feet 11 inches from the floor to the center of the hub or spindle. This distance varies, however, from 2 feet 10 inches to 3 feet, according to custom and the height of lock-rail or panel above the floor. He should see that the face and striking plates are neatly cut into the door and jambs, all butts set in flush with door and jamb rebates, and that the door is hung to swing clear of the architrave or plinth blocks. He should see also that all windows are provided with sash locks, lifts, etc.; that all cupboard, closet, and wardrobe doors are provided with the requisite locks, butts, etc.; that all drawers, etc. are provided with locks, pulls, and the wider drawers, previously described, set on

ball-bearing slides; that all annunciators, bells, push buttons, and speaking-tube plates, etc., furnished by the electrician, are properly hung in the places designated. He should also see that all closets, cupboards, wardrobes, etc. are provided with suitable hooks, and that all the hardware throughout is put on with screws to match.

138. Rough Hardware.—Usually the first hardware to be applied is that for the windows, which consists of weights, sash pulleys, and cord. The sash pulleys are often put on the window frames at the factory, and generally so with stock frames, but in the best work they are put in at the building, and should be at a uniform distance from the head of the pulley stile; they should be set in flush with the stile that the sash may not be injured after the sashes are glazed, and before they are hung they must be weighed. The size of the weights should be proportioned as follows: The two for the upper sash combined should exceed the weight of the sash by about one-half a pound, and for the lower sash should be about one-half a pound less than the weight of the sash. The other finishing hardware is applied after the first coats, and before the last coat of paint or varnish is laid.

The superintendent should bear in mind that the maker's name on a piece of hardware is not always sufficient, as most manufacturers make several grades of the same pattern, and, unless he is qualified to distinguish between them, he may be imposed upon; another point to look after is that of the hardware finish. He should he able to distinguish between lacquered or plated hardware and the solid metal. Scratching the piece of hardware on the back with a penknife or file is usually sufficient to discover whether it is lacquered or plated. The weight and color also will help to a certain extent, as, for instance, in bronze hardware, a door knob of solid bronze should be quite heavy, and where any milling has been done, as the socket for the spindle, the color of metal may be seen. Sometimes, however, the superintendent will have to be content

with the labels on the boxes in which the hardware is packed to determine its quality.

After all the hardware has been put on, the superintendent should go over the entire building and satisfy himself that all the doors swing properly, that they fit the jambs tightly without binding, and that all sashes, drawers, cupboard doors, etc. work freely and without friction. Having satisfied himself that everything is in good working order and that no planing of doors, adjusting of window stops, or such work is necessary, the painter may proceed with his work.

SUPERINTENDENCE OF THE PAINTING.

139. Method of Procedure.—Although the work of painting is to be described at this period, much of the work should be done previously. The priming coat of paint on the exterior woodwork of the main building and stable, as well as that on the belvidere and summer pavilion, is applied as soon as the carpenter work on the exterior is finished, in order to prevent warping or splitting of the wood. The staining of the shingles on the roof was done before they were set in position, and after the priming coat of paint on the buildings is dry, all nail holes are puttied up smoothly and the second coat applied to all woodwork. The buildings are left in this state until the exterior work of grading, and such work from which dust is likely to arise, is done; the last coat being applied at the time that the sodding and tree planting is being done.

The canvas floor covering of the summer pavilion is treated with a coat of raw linseed oil, and then finished with three coats of paint. In following this work, the superintendent should see that the materials are mixed on the ground, that the proper quality of material is used and mixed in a proportion to produce a paint having a good body. This constitutes the important part of his work, but the method of applying it will also require attention.

140. Exterior Work.—The superintendent should see that all sap or knots are covered with a good coat of strong

shellac before the priming coat is applied, and in applying the paint, that the outside plastering and stonework are protected; that the painting on the sashes is neatly cut in, and if any paint appear on the glass, that the painter be required to clean it off at once. The priming coat of paint for open timber staves and such exterior woodwork will be of a bright Venetian red, ground in pure linseed oil; the two other coats to be of dark olive green. The purpose of using red for the priming coat is to form a base which will lend to the olive green a mellow tone, that it will retain for an indefinite period. The superintendent should see that no crude or fish oil is used, the latter being easily detected by its smell; this oil is inferior and much cheaper than pure linseed oil, but it does not dry so readily. In applying the paint, the best results are obtained by stroking the brush parallel with the grain of the wood, and in the final coat the brush should be drawn along the full length of the piece of wood to produce a uniform effect. No piece of work should be started unless it can be finished the same day, for if the work is left at night unfinished and started again the next day a prominent streak will appear, detracting very much from the appearance of the work. The specifications require the wrought-iron gates, lamps, fence, and grilles to be painted a coat of red oxide of lead ground in linseed oil before leaving the shop. They are to be finished with two coats of white lead and linseed oil paint of an approved tint. The ceiling of the veranda, porte cochère, porch, summer pavilion, and belvidere to be finished natural with one coat of mineral wood filler, one of white shellac, and two coats of best spar varnish. The last coat to be rubbed down with pumice stone and water to a wax finish. The copper rain-water conductors are not painted, as they will assume a green color by oxidation.

141. Interior.—The more important part of the painter's work is that of finishing the interior woodwork, floors, etc., and the attention and watchfulness of the superintendent will be required to see that the proper materials are used, and that they are properly applied, which is almost as important

to produce the best work. Very little paint is used on the interior of the buildings, for the reason that the most of the interior finish is of hard wood, selected with reference to the beauty of its grain and color. For the finishing of white pine, etc. in the parlor or elsewhere on the first floor or above, a priming coat of pure white-lead and linseed-oil paint is applied. The puttying up is done after the first coat is applied, as previously described for outside painting, and then two coats of the same paint are applied, each coat being smoothed down with fine sandpaper as soon as it becomes dry. The woodwork is finished with two coats of paint composed of zinc white and spirits of turpentine. The last coat should not be sandpapered and should show a uniform surface without brush marks. The woodwork in the cellar is primed, the nail holes puttied up, and then finished with two coats of white-lead and linseed-oil paint of an approved tint.

142. Finishing.—The superintendent should see that the hard-wood floors, and all woodwork that is to be finished natural, is protected from paint spots, and if by any chance paint spots should appear, they must be thoroughly cleaned off without delay. The work of finishing the trim, doors, stairs, floors, etc. should be carefully looked after, to see that the specifications are followed and that the finishing material is put on carefully and conscientiously. The superintendent should see that the quartered oak and other open-grained woods are filled, and the work cleaned off as soon after as possible; that the quirks of all moldings are cleaned out before the varnish is applied, that all putty required for the hard wood is colored to match the wood, and that each coat of shellac, varnish, or other finishing material is rubbed down with pumice stone and water before the next coat is applied.

After the finished floors have been properly dressed down and sandpapered to a perfectly smooth surface, the open-grained floors, such as oak, etc., are filled with transparent mineral wood filler, and rubbed off before the filler becomes

hard on the surface. The floors are then finished with two coats of old English floor wax, applied with a woolen cloth; each coat is rubbed down with a weighted brush having a long handle. The last coat, which is polished by means of a piece of soft felt being placed under the brush, is not applied until the building is ready for occupancy. Floors finished in this way, if carefully done, should show a beautiful polish when finished, and after it becomes dull through wear, it may be brightened by another thin application of the floor wax, which may be applied by a servant or other person, no experience being necessary.

In applying fresco or distemper to walls, the superintendent should see that the walls are properly sized, and that careful men are employed to do the work; otherwise, a poor job will result. All rooms are to be finished in two tints.

143. Glazing.—The glazing of sash, etc., if to be done at the building, is usually included in the painter's contract; such is the case in this instance, the carpenter delivering the sash at the building and placing them in a convenient position, with their location in the building marked on each, that the painter may easily distinguish which is to have plain sheet glass, which plate glass, and which leaded or other metallic set glass. For sash having wood stops instead of putty, however, the painter will furnish the carpenter with the glass, placing it in the frame if necessary; but the carpenter is to put on the stops.

CONCLUSION.

144. Grading and Terracing.—The "spoil banks" which were reserved for use in final grading are now drawn upon; as the stakes about the roads indicate the grades and levels, a diagram being furnished by the engineer, no important problems are liable to arise in this work. The superintendent should see that as little clay as possible is allowed to be used, and after the various levels and terrace slopes have been laid out, the earth tamped down, etc., that

the top soil is spread out uniformly in the required thickness—8 inches—and brought to a smooth surface, tamped down, and raked over to receive the sodding. The flower beds are next laid out, and the top gravel dressing is spread upon the driveways and walks.

The sods should be inspected to see that they are free from weeds and that a sufficient amount of turf is taken with them to make sure that the roots have not been destroyed. The superintendent should inspect this latter work as much as possible, always consulting the landscape architect in the event of any part of the work being otherwise than as specified. The sods on the terrace slopes should be secured in place with wooden pins. The mason should maintain a requisite number of laborers about the premises, that any trenching, or other work of a like nature required by the other crafts, may be done without unnecessary delay.

The pits are excavated for the pier foundations under the summer pavilion on the north terrace. These piers are to be built 4 feet below grade of rubble masonry, 20 inches square, laid in cement mortar. Each pier is to be capped with a single stone, 6 inches thick, covering the pier. Two of the piers on each side are extended beyond the other piers for the support of the steps and cheek-blocks. Nothing in the way of hints for the guidance of the superintendent need be added here, except, perhaps, to check the depth of the piers below grade, the centers of each pier, and that the outside faces of the piers are on the same circle.

The fountain at the junction of the driveways is to be built 4 feet below grade and a recess is to be left for the service and waste pipes; the service pipe for the fountain is controlled from the main trap pit in front of the greenhouse, and the water may be shut off at the approach of freezing weather. The foundation below grade is to be built of rubble laid in strong cement mortar, and the pedestal work above grade to be of sandstone; the trough to be of granite, polished, and in one piece; the work above the trough to be of bronze; this work is to be done according to detail

drawings and it will be the superintendent's duty to see that they are accurately followed and that the fountain is in good working order at completion.

A lamp pedestal is built at the junction of the driveways, and the foundation for this is built in a manner similar to that in the fountain. The foundation will be 2 feet square, 4 feet below grade, and provision made for reception of service pipe and conduits. The lamp pedestal will be in one piece of limestone with a hole bored through for the conduit and gas service pipe.

It will be necessary for the mason to have stone cutters at hand for further cutting of the cheek-blocks at each side of steps to the greenhouse, and at the carriage pillar for the vent gratings in the plumbing system, as well as other necessary cutting or fitting required.

The finishing touches are being given to the building by the painter and the work generally is about completed. The superintendent should make a final tour of all the work and make notes of any defective painting, stains on masonry, or patches on woodwork uncovered by the last coat, or in fact any such details that may be readily fixed up, and see that they are done. As nothing further is to be done by the superintendent on the premises after he has attended to all the above small details, his duties may safely be considered at an end.

CONTRACTS AND PERMITS.

INTRODUCTION.

1. Scope of Subject.—Under the above title, this section will treat separately and distinctly of two subjects. "Contracts" will be explained and discussed in such a manner that the student will be able to acquire a practical knowledge of the business relations that exist between the several parties to a building operation, and to comprehend the relative positions of these parties in the eyes of the law. The parties to a building contract are usually the builder, the owner, and the architect, though in some cases the architect is not a party to the building contract at all, and his name does not appear in any of the documents.

Under the head of "Permits" will be considered the application for, and acquirement of, permission or authority, from municipal officers, to engage in certain building operations, which could not be performed without the consent of certain city departments. Small communities seldom require any such formality before building operations are commenced; but in large cities it is necessary to provide for public safety, by causing all operations of building construction to be subject to the approval and supervision of a competent board of inspectors, usually known as the Building Department.

Building contracts are nearly always between owner and builder, with the architect as third party and arbitrator; but

building permits are business details usually between the builder and the municipal authorities, for which the builder pays the fee, if any is charged. The obtaining of all permits may form a part of the contract between owner and builder, but further than that the owner seldom has anything to do with permits at all.

CONTRACTS.

CHARACTER OF THE AGREEMENT.

NATURE OF A CONTRACT.

2. Definition.—A contract is an agreement between two parties for doing or not doing some definite thing. It is very clearly defined by Woolsey ("Introduction to International Law") as, "One of the highest acts of human free will, binding itself in regard to the future, and surrendering the right to change a certain expressed intention, so that it becomes morally and jurally a wrong to act otherwise; it is the act of two parties, in which each, or one of the two, conveys power over himself to the other, in the consideration of something done or to be done by the other."

In the strictest sense, a contract is an agreement enforcible by law—an agreement based upon sufficient consideration, and in such a form, and made under such circumstances, that a breach of it is good cause for action by law. It is this sense of validity before the law which distinguishes it from an agreement, the parties to which are not bound in such a formal way, and are not amenable to one another for its fulfilment.

3. Parties to a Contract.—In the execution of every building operation of any size, there are at least three persons interested—the owner, the builder or contractor, and the architect. The owner is the person vitally interested, because it is his money that is being expended, and it is natural that he should want to receive the best material and

workmanship, consistent with the size and quality of the building to be erected, and the amount of money to be spent. The builder, who is party to the contract, agrees to accomplish certain results for a stipulated amount of money, and, in deciding the extent of his responsibility towards the owner, is apt to interpret the contract to best suit his own interests. The architect is employed by the owner as a person expert in matters of building, and is the judge who decides for the owner whether the builder is doing his duty and fulfilling his contract.

Though all men are deemed honest unless proved otherwise, it may readily be seen that a dishonest builder might, unless some valid agreement existed, make considerable trouble for the owner. The builder is even more at the mercy of a dishonest owner, for he might be led into a building operation which would require the expenditure of considerable time and money, which he would be unable to collect after the erection of the building. This would more than likely put him to additional expense of long and wearisome litigation, which, though the courts sustained his claim, might cause bankruptcy before he could recover it.

Even though each of the parties should be perfectly honest, and inclined to deal fairly with each other, it is necessary to have a contract that will stipulate the terms of the agreement in a perfectly clear and concise manner—drawn up, agreed to, and signed by each party concerned—so that each, over his own signature, will have defined for him his responsibilities and duties in the transaction.

4. Classes of Contracts.—Contracts may be divided into three classes: written, oral (or as it is sometimes called, parol, or verbal), and implied contracts.

A written contract is one wherein the terms of the agreement are written or printed, and signed by the contracting parties.

An oral, or verbal, contract is one in which the parties concerned agree verbally (usually in the presence of witnesses) to transact or perform certain things.

An implied contract is a contract that is *understood* to exist, through the very nature of things, between two parties without any previous written or verbal agreement. For instance, one person employs another to perform a certain piece of work and thereby implies an obligation for reasonable renumeration to the party who performs the work; or a person accepts the benefits accruing from the performance of such work, and thereby implies an obligation to have satisfactorily performed the labor for which he was paid.

Most contracts embody at least two of the above mentioned conditions, for the reason that it is almost impossible to fully cover all the terms of an agreement in a written or oral contract, and much must be implied if a successful performance of the work is understood.

5. Written Contracts.—A written contract is usually regarded, though incorrectly, as more binding than either of the others. Its preference over the other forms lies in the fact that the statements of the agreement are in black and white, and being signed by the parties concerned, cannot well be refuted; and since a certain amount of formality is required, in order to draw up a written contract, the law regards the document as the finished and definite conclusion of all the preceding negotiations of the contracting parties, and as fully expressing the understanding between them in regard to the terms of the agreement.

The fact that verbal agreements are regarded in such an unfavorable light by the law is probably due to the fact that witnesses, and parties to a verbal agreement, when called upon in court to testify, so utterly fail to agree in their statements as to what really was said upon the specified occasion. The court is, therefore, inclined to accept and hold paramount any document that will explain, in any degree, the real understanding between the contracting parties. Hence it is, that even a note in the memorandum book of one of the parties concerned, or in a book of a third and disinterested party, as to the terms of the agreement, will be looked upon with favor by the court, and will usually be held, where it is

proved to be genuine memoranda, as testimony of importance above that of a witness to the verbal transaction.

6. Oral Contracts.—It must not be thought that, in the absence of written documents, verbal contracts or agreements can be broken with impunity by either party, for such is not the case, as it is the custom of the courts, in matters of this kind, to endeavor to ascertain, by witnesses and circumstances, the real understanding existing between the parties to such a contract, and to deal fairly with them, commensurate with the testimony and evidence given.

7. Implied Contracts.—Where the owner of a building stands by and sees certain improvements made, or labor performed, from which he will derive benefit, he implies a contract for the work, and is in duty bound to pay a commensurate price for the same, unless there is some stipulation to the contrary in a definite contract, or where there is some written document, subsequently made, which in some way nullifies this implied contract. For instance, the written contract may set forth that "No payments shall be made for extra work done by the contractor unless authorized, in writing, by the owner," or "by the architect." In this case, if the contractor does any extra work for which he has no written order, he does it at his own risk, and would have no action against the owner in court.

In order to make clear the extent of an implied contract, the following illustration is of interest: A plumber was subcontractor to a builder during the erection of a house; the builder was subsequently discharged by the owner for drunkenness, but the plumber went on with his work, under the observation, and in some instances, under direct orders of the owner. Having finished his work, the plumber looked to the owner for his money, which was refused on the ground that the builder had already been paid for the work. The plumber brought suit for the amount of the job, and, though it was proven in court that the builder *had* been paid enough on the building to cover the plumber's claim, the court recommended that, if the evidence warranted it, the jury should

oblige the owner to pay the plumber for at least such work as he had done subsequent to the builder's discharge. This view of the case was taken by the court on the ground that "Where one stands in silence and sees work done, or materials furnished for work done upon premises belonging to him, of which he accepts the benefit, a promise to pay the value thereof may properly be inferred."

8. Contract by Tender.—Where designs or plans are submitted in compliance with the terms of a circular or printed notice, setting forth an invitation for such designs or plans, and offering some inducement for same, it is regarded and has been declared by the courts to be a contract. In order that the validity of such a proposal be made certain, its terms should be set forth clearly and distinctly, and the person accepting the terms should comply with them strictly and to the letter. Proposals of this kind are advertised by committees or individuals, who call for competitive drawings of some public or private building. The submission of plans or designs in strict compliance with the terms of the advertisement constitutes a contract which is upheld by law, provided that the advertisement is issued by persons of proper authority and responsibility.

Should a committee call for architectural designs which are to comply with certain conditions or requirements, and by subsequent notice modify these conditions to such an extent as to make worthless certain plans partially prepared by one of the competing architects, said architect would be able to recover the cost of such preparation. But if he had not commenced the designs until after the modified circular of advertisement had been issued, the later program would take precedence over the first, and be held as embodying the terms of the contract.

Should the committee set forth conditions that it would be impossible for an architect to fulfil in the design of any one building (such as a demand for certain accommodations, which could not be provided for the stipulated sum of money), the architect should get the vote of the committee

as to which requirement—cost or accommodation—takes precedence, and which he is to disregard. The opinion of any one member of the committee is not sufficient, and only the joint decision of the entire committee should be accepted. Therefore, in issuing circular invitations for proposals, or competitive drawings, great care should be taken to state in clear terms just what is wanted and required, and equal care should be exercised by any one complying with the terms, for not only has the law but little relief for persons who do not know how to express their ideas, but it also extends little hope to those who cannot understand a clear statement and who misconstrue the intent of the published requirements.

THE CONTRACTING PARTIES.

9. Formal Contracts.—A formal contract consists of a direct and pertinent proposal from the one party, and an unconditional acceptance by the other. Such a contract may be made by a letter proposing certain terms, and duly accepted by a letter in reply, or the more usual form of a written agreement, setting forth in full the requirements of the one party, and the unconditional acceptance of them by the other, and signed by both parties. In all formal contracts, the terms must embody every condition that is to be complied with, and should be so explicitly stated as to be clearly understood by the contracting parties, so that there may be no misunderstanding between them in regard to the performance of the one party, and the demands of, and consideration to be paid by, the other.

10. Contracting With Corporations.—An agreement entered into with a corporation differs very materially from one contracted with an individual. Almost any contract (provided it is not immoral) is binding upon an individual, providing the intention is well defined and understood, and a consideration is to be made for its fulfilment. Such, however, is not the case with a corporation. It behooves the person about to make a contract with a corporation to

inquire into the scope of its charter, ascertain the limit of its powers to make such contract, and the authority of its officers who are to negotiate the contract. In England, a contract requires the seal of the corporation, in addition to the signatures of the proper officials, in order to insure its validity, and such was formerly the case in the United States, though in many of the states the signatures of the proper officers are generally considered sufficient, providing they have the required authority through their charters, and by laws. In fact, courts in so many of the states have taken this view, that it is more than likely, should similar cases arise in the other states, the courts would hold the same opinion. Irrespective of the matter of the seal, however, it is of vital importance, in making a contract with a corporation, to ascertain whether the persons representing the corporation are invested with the proper authority to make such a contract, and that the corporation is bound to recognize it. There is no redress, and no action will be sustained, if the person entering into a contract with a corporation has, through his own neglect to obtain such information, entered into a contract with officials lacking the proper authority, and at variance with the charters and by laws of the corporation.

11. Public Contracts.—In entering into a contract with a public body, even when the officials representing such a body are duly authorized, it is imperative to make the contract with due formality, or it will not be legal. For instance, it has been held in several states, that the county was not bound by a contract entered into by the county commissioners unless the commissioners were convened in a regular meeting of the board. A contract entered into informally, even within the legal authority of the officials, is insufficient.

When a contract is made with a public corporation, for work to be performed under the supervision of a committee, such as a town committee, the contractor should ascertain whether the contract is made through the concurrence of a majority of the committee. Not only does this apply to an

original contract, but also to any alterations to be made in one already entered into.

The contractor, in other ways, runs many more risks in dealing with corporations than he does with individuals, for a mechanic's lien is without effect against any public building, such as a schoolhouse, jail, court house, or town hall; and even aside from state, county, and town corporations, no such lien can be maintained against the property of a corporation operating for the accommodation of the public, such as railroad stations, ferry houses, etc.

Again, a public corporation is sometimes *exempt* from fulfilling its contract. An instance of this occurred in New York, when a contract was made for a public building. The erection, however, was postponed, and the contractors brought suit to force the fulfilment of the contract, but, though the contract was drawn with due formality and was perfectly legal, the court of appeals decided that a state could not be compelled by a contractor to erect a building, and that his only redress—providing the state broke the agreement, and he himself was not in default—was a claim for damages, which must be made in the form of a petition to the state legislature.

12. False Representation.—Through lack of caution on his part, a contractor frequently finds he has made an agreement with persons who, though they have represented themselves as authorized to execute the contract, have no such legal authority. The corporation therefore refuses to pay the contractor his consideration, and he has no action against that body, though he may possibly recover damages from the persons who caused him to enter into the contract under false representations. It is therefore a good plan, and a safeguard to both parties, to have this matter clearly defined before the agreement is signed. It is, in fact, sometimes a matter of doubt whether the members of a committee who sign their names to a contract for building, to be paid for by a public corporation, do not sometimes, through the wording of the agreement or the manner of signing it,

make themselves each personally liable for the amount of the contract.

13. The Lowest Bidder.—It is the common supposition that the award of a contract must be made to the lowest bidder, unless there is a statement in the tender for bids which stipulates that the parties making the tender "reserve the right to reject any or all bids." This is not the case, however, as no such stipulation is required, and the parties making the tender can omit such a clause without being bound to prefer the lowest bidder. The laws of some states, and many public and private corporations, require that bids shall be asked for all work involving an expenditure above a certain amount, and the proposal of the lowest bidder accepted. This being the case, the officials making the contract are bound to award it to the lowest bidder. When the stipulation is made in the tender calling for bids upon certain work, that "the contract shall be awarded to the lowest responsible bidder," the discretion allowed the parties making the tender is so great in regard to what they may consider as constituting the "responsibility" of the bidder, that the law virtually admits that they may award the contract to whomsoever they may see fit, so long as they have decided truly in their own minds which party is the lowest *responsible* bidder.

The extent to which parties may be held in awarding a contract, by the statement in the tender, that the award shall be made to the "lowest bidder," is well set forth in the confirmation of a decision by the Supreme Court of Pennsylvania. A case arose in Pittsburg, where the water committee awarded a contract for some mains to a party who was $5,000 higher than the lowest bidder. The lowest bidders, having complied with all the terms of the tender, and furnished the proper bond, felt that they were entitled to the contract, and applied for a mandamus in order to compel the committee to award the contract to them. The committee, in reply to the court's inquiry to ascertain if the mandamus should be granted, stated "that it was within their full

knowledge and belief, that upon a previous occasion the said firm had by some means or other attempted and did perpetrate a gross deceit and wrong upon them, in surreptitiously departing from the specifications for a certain contract for the construction of boilers for the new water works, by striking therefrom, without the knowledge or consent of the said committee, the word *mud-drum;* also that it was within the knowledge of some, if not all, the members of the water committee, that the senior member of the firm was a man of intemperate habits, whose character for sobriety was not such as would warrant the committee in giving said firm a responsible contract; that said senior member also had attempted to bribe the mechanical engineer of the water works, who was the inspecting officer of said contract; they further stated that the firm was otherwise disqualified for the proper fulfilment of the requirements of the proposed contract." The report of the commissioner appointed in the case to take testimony, showed that the said firm was the lowest bidder, and from a pecuniary standpoint was responsible; and while, in the opinion of the commissioner, the committee fully believed that the statements made were true, it was found that inquiry on the part of the committee would have shown that none of the three accusations made, as to attempted deceit, intemperance on the part of the senior member, and bribery of the engineer, was substantiated. Notwithstanding this, the court held that the committee's action could not be changed.

The Supreme Court, in the confirmation of the lower court's decision, said: "The learned judge who, as the mouthpiece of the court to which this case was submitted, delivers the opinion, finds that the facts stated in the petition are true, and that the allegations contained in the answer, as above set forth, are wholly without foundation, but that, notwithstanding this, the committee fully believed that what was asserted in the answer was true. We must take this opinion of the court as to the belief of the respondents to be correct; nevertheless, it does somewhat surprise us, that this body of men, intrusted with so important a duty, should

have rested so contentedly under a delusion which a little inquiry in the right direction would have dissipated, and thus save a handsome sum of money to the city treasury.' In regard to the word *responsible* the court held that it means something more than pecuniary ability, and further stating the case said, in a contract such as the one in controversy, the work must be promptly, faithfully, and well done; it must, or ought to be, conscientious work; to do such work requires prompt, skilful and conscientious men. A dishonest contractor may impose work upon the city in spite of the utmost caution of the superintending engineer, apparently good, and even capable of bearing its duty for a time, which in the end may prove to be a total failure, and worse than useless. Granted that from such a contractor, pecuniary damages may be recovered by an action at law, this at best is but a last resort, that often produces more vexation than profit—a mere patch upon a bad job—an exceedingly meager compensation, at best, for the delay and incalculable damage resulting from the want of a competent supply of water. The city requires honest work, not lawsuits. Were we to accept the interpretation insisted upon by the relators, the difference of a single dollar, in a bid for the most important contract, might determine the question in favor of some unskilful rogue, as against an upright and skilful mechanic. Again we know that, as a rule, cheap work and cheap workmen are but convertible terms for poor work and poor workmen, and if the city, for the mere sake of cheapness, must put up with this, it is indeed a most unfortunate position. It is settled beyond controversy, that where the complaint is against a person or body that has a discretionary or deliberate function to exercise, and that person or body has exercised that function, according to the best of his or its judgment, the writ of mandamus will not be granted to compel the undoing of what has been done."

Bidders for public work under the statute that work shall be given to the lowest bidder, must comply strictly with the terms of the tender, if they expect their proposal to be accepted, or even considered as the lowest bid.

THE SIGNATURE.

14. What a Signature Implies.—Since a contract is a mutual agreement between two parties, it becomes essential to its legality that there should be available proof of the fact that both contracting parties thoroughly understand it in the same way, and willingly assent to the obligations incurred by the conditions—in other words, that the parties are of one mind. Therefore, when the signatures of all the contracting parties are affixed to the document, setting forth the terms of the contract, they are deemed by law as evidence of this mutual agreement and understanding, and impart validity to the document.

A signature may be the inscribed name by which a party is known, or in case he cannot write, his mark, or cross, will be regarded as legal, providing it is witnessed, and his name is written near it in the customary way and by a duly authorized party. It has been held, however, that a signature "by mark" is *not* valid if made by the other party to the contract, for the one signing the contract by mark.

There are cases where it is not necessary that a person should sign a contract in order to be bound by its conditions. When a person who is a party to a contract is mentioned in it as one of the signers, and acts as attorney for another party to the same contract, he signs as attorney for the other person, and does not sign on his own account; nevertheless, it has been held in court, that since he must have read the document before signing it as attorney, and must have seen that he was personally mentioned as one of the signers, by failing to make any remonstrance against it and by accepting its benefits, he assented to its terms and became a party to its fulfilment, the same as though he had signed it in his own name. It is reasonable, therefore, to suppose that any person, knowing the terms of a contract, and being aware that he is personally interested in it, who stands by, without resistance or remonstrance, and sees it drawn up, and afterwards accepts the benefits recurring from such agreement, will he held responsible by law, and will have no excuse on

the ground that his actual signature is not upon it. Nor will the law excuse a person who has signed a contract, on the ground that he has not read it over, providing it is proved that he is able to read, and had an opportunity to read the document, and that no means were used to prevent him from reading it. The plea that it was written in a foreign language, unfamiliar to him, will not release him from the obligations of the contract. Therefore, before signing a contract, the party about to affix his signature should read it over carefully, in all its parts; not only should he read any printed matters that may be embodied in it, but he should consider carefully any script that may be interlined between the printed substances, as writing is held by the courts to take preference over printed statements, and where there is any inconsistency existing between the two, the written portion controls, as more attention is usually paid by the contracting parties to the written matter. No party is, however, excusable upon the plea that he did not read the printed form. Such a case was tried in the District of Columbia. The party, upon having the written part of an agreement read to him, ordered his signature to be placed on the instrument, without reading or having read to him the printed substance of the agreement. As it was proved that he could read, and had an opportunity to do so, it was held by the court that he was responsible for the agreement, in the terms and to the purport of the entire document.

15. Unsigned Agreements.—A contract signed by one party and then delivered to the other is binding upon the one who signs the agreement, whether the other party signs it or not. Such a case was decided in the Supreme Court of New York. A party, receiving an unsigned agreement by messenger, affixed his signature, and upon handing it to the messenger remarked that he would not be bound by it unless certain things were done. He afterwards wrote to the other party to the agreement that he refused to be bound by it, and withdrew. The court held, notwithstanding the fact

that it was not signed by the other party, that the party who had signed it was bound, and that parol evidence of conditions qualifving the delivery was not admissible.

THE CONSIDERATION.

16. Compensation.—Every agreement, unless under seal, must have some specified consideration, or payment for services rendered, stipulated in its terms, in order to make it valid; for, although a contract may be properly executed and signed in the presence of witnesses, yet, if there is no consideration mentioned—that is, no remuneration to the party for performing labor—or furnishing material—the contract will not be legal, and cannot be enforced in law. The remuneration may be either money, labor, or materials, but there must be some statement to show that neither party is furnishing goods nor working without recompense from the other. An effort is often made in cases involving the enforcement of a contract to prove that the entire agreement, or a portion of it, or some supplementary agreement, was without promise of consideration or remuneration, and therefore of no force; and if the court takes this view of the matter, the contract cannot be enforced.

This is such an important item in assuring the validity of a contract or agreement, that it is wise to commence every agreement, even if involving but a small amount, in somewhat the following manner:

"*For the consideration hereafter to be mentioned* . . . . . *A* . . . . . *promises and agrees to deliver certain goods* (*or do certain work*) *for* . . . . . *B* . . . . . ;" the consideration should then be specified in detail, in another place in the agreement.

The amount of the consideration matters little, for if a man be so unwise as to offer to build a house for a party in consideration of the sum of one dollar, the court will hold him to do his contract, though he might be ever so much inclined to withdraw from such an unprofitable agreement.

17. Sealed Contracts.—Sealed contracts constitute an exception to this rule; for, in the language of the law, a seal "imports a consideration," and therefore a seal, placed in a legal manner after each signature upon a contract, will take the place of the stipulated consideration, and make binding all the promises contained in the contract, admitting no opportunity on either side to renounce these promises, or any part of them, even where no consideration is mentioned. Formerly, the seal consisted of a drop of sealing wax, upon which there was impressed the peculiar signature of the party concerned; or in some cases, merely the end of his thumb was applied to the soft wax, and its imprint acted as a signet. In these days, however, the private seal is usually a piece of red paper affixed to the document with mucilage, and even this formality is not required in some states, which consider a blot of ink an adequate seal. It can therefore be readily seen that it would always be best to have the signatures to a contract under seal, as in this case there would be no possible opportunity for dispute in regard to the consideration by the parties, as in affixing their seals to the agreement they mutually consent to its terms, irrespective of a consideration.

PAYMENTS.

18. Entire and Divisible Contracts.—All contracts may be divided into two classes, entire and divisible. *Entire* contracts are those which provide that a certain complete performance shall be paid for upon its entire accomplishment; while a divisible contract is one which is complete in its several parts, the proportionate cost being paid in several instalments. In the *entire* agreement the party performing the contract is not entitled to payment until it is completed, while in the *divisible* contract he may collect part payment at the completion of each stipulated part. A good example of a divisible contract is one which provides for the building of twenty houses at so much for each house. In this case the contractor would be entitled to receive payment for any number he had finished, whether the entire twenty were

completed or only one. A contract, therefore, which consists of an agreement by the one party to perform certain work, complete in itself, and of an obligation by a second party to pay so much for the work, will not allow the first party to collect any portion of the entire consideration before the completion of the work; and, should he fail to complete his portion of the contract, he would be unable to collect *anything* for work done or material furnished, provided his failure to accomplish it was not due to any interference by the second party, or by law. If, however, the agreement should stipulate that payments be made at stated periods, as the work reached certain designated stages, a court may decide that owing to the terms of the agreement the contract becomes a divisible one, and that the builder or contractor can claim payment for such portion as may be completed, even should he fail to carry on the work to completion; but in all probability the courts of the different states would decide differently on this question of divisibility of contract, as it is frequently a difficult one to settle. As a building contract is divided more or less into a number of separate clauses and stipulations, relating to separate parts of the building, quality of material, workmanship, etc., it might be held in some courts that it is a divisible contract, and the contractor has a right to recover for labor performed and material furnished, on a portion of the contract.

THE ACCEPTANCE.

19. Accepting a Contract.—Much uncertainty exists as to how soon a proposal should be accepted, and the courts have spent much time on cases involving this question. In one case a person wrote to another offering employment, and requesting a prompt reply. The offer was accepted by the person to whom it was made on the day following its receipt, and the letter of acceptance was handed to a boy to mail. The boy neglected to mail it until two days later. In the meantime the person offering the employment had secured some one else to fill the place. In the suit which followed

to compel the employer to keep to his proposal, it was held by the court that the time elapsing between the offer and the acceptance was too long, and the proposal did not hold.

In the state of New Jersey, it has been held that where the offer specifies that it is open until a certain date, an acceptance upon that date is binding, unless the offer has been withdrawn previous to acceptance.

The question frequently arises, where the acceptance is made by letter, as to whether it may be considered as taking place, and consequently the contract closed, at the time it is mailed by the party making it, or not until it is received by the proposer. English law considers the acceptance made, and the contract closed, from the moment the letter of acceptance is delivered into the hands of the messenger who is to take it to the party making the proposal. This view seems to be held also in the states of New York, New Jersey, New Hampshire, Illinois, and Mississippi, but may be held differently in other states. The courts of Massachusetts, as well as the federal courts, hold that the contract is not binding until the acceptance is received by the party making the proposal. The posting of a letter of acceptance is usually considered as equivalent to its delivery to a messenger, and binds the contract, even though it is not received by the other party. There are exceptions to this, however, since the New York Supreme Court decided in one case where there was no proof that the postage had been paid, that the acceptance was not complete. It should be remembered that the courts, in dealing with such uncertain questions as the above, are usually governed by circumstances and the intention of the parties concerned, rather than by abstract law principles and rulings.

The decisions of the courts in regard to telegraphic acceptances are quite varied, and, strange to say, are in some cases in opposition to their decisions in regard to acceptance by letter. It has been held in the federal courts that an acceptance by telegram is binding the moment it is placed in the hands of a telegraph company for transmission; while, in acceptances by letter, as previously stated, they

hold that it is not binding until received by the proposing party. Again, the New York courts hold that an acceptance by telegram is not binding until received, while, in regard to letter acceptances, it has been decided in the same state that it is binding at the time it is posted.

20. Extent of Obligation.—It is held by all courts that all bids must be accepted unconditionally as made, without variation from the original proposal. If a person in accepting a bid bases his acceptance upon any conditions differing from, or contingent upon, any change of the original proposal, the bidder is not bound by it, and may refuse to sign the contract; and, even should he remain silent, thus apparently accepting it, he cannot be held to it; and, though the party made a subsequent unconditional acceptance, the contract would not be binding. Such conditional acceptances are of common occurrence among architects and others, who, upon receiving bids for the performance of work, will write to the favored bidder that his proposal is accepted, upon the condition that he will sign a satisfactory contract. Such an acceptance is not binding, and the bidder could withdraw his proposal if he saw fit, and could not be held responsible.

In the acceptance of a proposal the price named is often found to be a little less than the price asked by the contractor for doing the work; whether this is unintentional, or whether it is a trick of unscrupulous parties, the fact remains that an acceptance in this way is not only in no way binding upon the contractor, but actually releases him from his original offer. The assumption of the courts in regard to acceptances, or proposals, is clearly expressed by an Illinois court, as follows: "A proposal to accept an offer, on terms varying from those proposed, amounts to a rejection of the offer, and a substitution in its place of a counter proposition, which cannot become a contract until consented to by the first proposer. The original offer thereby loses its vitality, and is no longer pending between the parties, and it becomes an open proposition again only when renewed by the party who

first made it; hence, the party who submitted the counter proposition cannot, without the consent of the other, withdraw or abandon the same, and then accept the original offer, which he had once virtually rejected."

21. General Conditions.—In order that bids may be comprehensively and understandingly made, the architect usually prefaces the detailed specifications with a clause covering all the *general conditions* which are to be complied with by the contractor. (See *Specifications*, Art. **5.**) This portion of the specification includes all general stipulations concerning terms of payments, time of completion, compliance with building ordinances, the obtaining of permits for water, blocking street and sidewalk, etc., together with other stipulations of minor importance. The contractor in bidding on the work accepts *all* of the specifications, including the general-condition clause, and upon the acceptance of his proposal he becomes bound in contract to all the terms of the specifications.

It is sometimes advantageous for an owner to accept unconditionally and promptly an especially favorable bid without the risk of a conditional acceptance, which would give the contractor a chance to withdraw. The owner in such a case runs no risk if proper general conditions have been embodied in the specifications, as a contract thus made is perfectly valid, and the builder in subsequently signing a formal contract that contains additional stipulations regarding insurance, time of payment, etc., usually does so with advantage to himself. Should the specification not embody adequate general conditions, however, and the bid be accepted unconditionally, such a contract is equally valid, but the contractor can be held only for such stipulations as are mentioned in the specification. If the time of completion is omitted, the court will decide that a reasonable time is understood, though the legal idea of "a reasonable time" is likely to be at variance with that of the owner, much to the latter's dissatisfaction. Other terms, of still greater importance, may be found to have been omitted from the insufficient general

conditions in the specifications, which will cause the owner much trouble and annoyance.

22. The Position of the Architect.—The architect sometimes oversteps his authority by accepting a proposal, without having duly consulted the owner. The extent of the architect's power in this direction has not, as yet, been determined by law, and the zealous architect who accepts a bid in behalf of his client, without consulting him, is likely to be placed in an awkward position, should the owner refuse to accept the proposition. Therefore, if the owner is desirous that the architect should be empowered to accept immediately, at the time at which it is made, any proposal which would be to the owner's interest, he should authorize the architect to do so, either giving him full power, or limiting him to such an extent as he may see fit. The authority of the architect to accept bids and proposals is of vital importance to the contractor, who is liable to discover that he has made his contract through a person unauthorized by the owner. Therefore, in all cases where the slightest doubt exists in regard to this, it behooves him to ascertain *at once* that it is the owner's intention that the architect should be so empowered, and that the architect's acceptance will have the owner's subsequent approval. The architect, in accepting a bid for the owner, should exercise due caution in the wording of the acceptance, so that he may not himself become involved in its obligations, and his letter should plainly show that he is acting solely as agent for the owner by stating that "Being duly authorized by Mr. A. B. (owner), I hereby accept in his behalf your proposal;" or, "Through the instructions of Mr. A. B. (owner), I am authorized to accept for him your offer."

23. Withdrawing or Modifying a Proposal.—Although somewhat a matter of doubt, the general rule with regard to the withdrawal or the modification of a proposal is, that until accepted the proposal remains a proposal only, and may, up to the time of its acceptance, be withdrawn or modified. In the case of a proposal sent by letter, there is

no doubt that the offer is open until the letter is received, and if the person making the offer can telegraph his withdrawal so that it will reach the proper person before the original proposal, the offer is nullified, and the parties interested in it are in the same relation as they were before the offer was made. But it has been held that if a person *receives* a proposal and immediately sends an answer accepting it, the offer stands valid, even though the party making the offer has despatched another letter in the attempt to withdraw it.

24. Delivering a Contract.—The formality with which the contract is delivered is of little importance, for if it is left at the place of business of the party concerned, the delivery is deemed complete, unless otherwise stated in the contract itself. A court in Illinois has held that one copy of a contract, between owner and builder, being left in the care of the architect, had, to all intent and purpose, been delivered, and was binding on both parties.

Where there are several copies of a contract, which are presumed to be alike in their terms and statements, but where, in fact, some difference exists between them, either party complying with the terms of the agreement in his possession is responsible only for the terms of his own copy.

MODIFICATION OF CONTRACT.

25. Modifying Contracts.—Though formal contracts are generally made with due consideration and carefulness, and are looked upon by the law as binding and enforcible upon both parties, still it is human nature to be fickle and changeable in mind, and unforeseen events may transpire which change the aspect of affairs entirely; hence it becomes necessary to provide that an agreement may be changed or modified in some manner, if so desired by both parties. This result may be accomplished either by *agreement* or by *waiver*. Where modifications in a contract are desired, such changes may be made by a mutual agreement between the

contracting parties. This amendment or modifying agreement, whether made at the time at which the formal contract is drawn up or later, has equal force with the original contract and is considered together with it. Many courts have held that such an agreement is valid, even when verbally made, unless there is a stipulation in the more formal agreement that no change or modification shall be made in the original contract unless in writing.

Caution must be observed, however, where the contract to be modified is with a corporation (especially so if a public corporation), to see that all such changes and modifications are made with due formality; unless this is done, the contractor may have cause to regret his carelessness.

26. Sealed Contracts.—Since a contract under seal is regarded by the courts to be a more formidable instrument than a simple contract, owing to the formality with which it is executed, most courts are more severe in regard to any change or modification in a sealed contract, as shown by the following opinion of the court: "While a simple contract reduced to writing may be varied or changed in any way by a subsequent verbal agreement, it is otherwise as to contracts under seal, which cannot be varied by a mere parol contract, whether in writing or not, since such a contract is inferior to the original." Hence, as nearly all formal contracts, whether of corporations or individuals, are under seal, it is evident that great caution should be used, and that no attempt should be made to modify any such contract otherwise than in writing, and with all the formality which attended the execution of the original document. It has been held in court that "a sealed contract cannot be rescinded or released by a parol agreement." It is admissible, however, according to a decision given in the state of Illinois, to subsequently agree verbally to pay an additional price for the same work as is stipulated in the written agreement, which agreement will remain valid in all particulars, except as to the price mentioned in the original document.

A contract that is not under seal may sometimes be

changed or modified by an implied agreement; that is, should a man by his actions declare certain intentions, which vary from the original contract, and should these intentions be accepted by the other party, also provided there was no stipulation in the contract that required "that all changes from the original agreement should be made in writing," a court may hold that the implied agreement to change the original contract, was the mind and intention of both parties, and was therefore binding, Even when there is a clause in the original contract excluding any change by verbal or implied agreements, the court will, under some circumstances, uphold such changes, providing the intention of both parties can be proven beyond doubt to have been agreeable to such a change.

27. Liability of Owner.—That "silence gives consent" does not always hold good in law; in fact, very frequently the opposite is true, and such a view is usually taken by the courts in cases where it is held that the contract or portions of it have been waived by implication. If an owner should observe, in silence, deviations from the contract, it does not necessarily follow that he must accept or pay for such changes. In the first place he may not be an expert in building matters, and again he may not fully realize the importance of such changes, though, if it could be proven that he favored such changes and assented to them, knowing that there would be additional cost attached thereto, it is likely that the court would hold him responsible. In regard to this a Pennsylvania court held that "it is no excuse for nonperformance, that the employer looked on while the work was in progress, unless there be evidence from which his assent may be implied."

28. Invalidation.—Many contractors are of the erroneous opinion, that where there have been a number of changes and modifications from the original contract, that such changes and modifications invalidate it and they are privileged to ignore the original agreement in regard to price and demand day-rate wages for the work. Such, however, is

not the case, and all courts of justice will endeavor to obtain evidence to show what portions of the original contract remain intact, and have not been mutually waived, and will enforce those portions accordingly. Where it is impossible, owing to the complications arising from numerous waivers and changes, to ascertain the terms of the original agreement, and in what relation they exist in regard to the actual work done, the court will endeavor to ascertain the reasonable cost of the work and material, and award the contractor his claim on that basis, holding that, "when the original plans, on which the contract was founded, have, by mutual consent, been so substantially and materially departed from as to amount to a constructive abandonment of its terms and specifications, the case should be regarded as one of general employment, with an implied obligation by the owner to pay what the work and material are reasonably worth."

CARRYING OUT THE AGREEMENT.

DEPARTURE FROM THE CONTRACT.

29. Substantial Fulfilment.—Departure from a contract may be either through carelessness or wilfulness. The decision a New York court has rendered in regard to such departure is well stated in a report as follows: "Parties to building contracts should be exact in the fulfilment of their agreements, even to the smallest particulars; and if they wilfully or carelessly depart from any one of them, they should incur the penalty, however severe it may be. But if a party, while acting in good faith, and with a determination to do all that he has contracted to do, unintentionally, and without any negligence, happens in some trifling matter to vary or depart from the terms of the contract, the law is not so severe and exacting as to deprive him of all compensation; it ever regards the substantial rights of the parties, but overlooks trivial and unimportant matters."

To just what extent the court will hold a person for such

deviations from a contract is somewhat undeterminable. It is, however, a foregone conclusion that the party will be held to the substantial fulfilment of his contract, the court deciding just what is meant by "substantial fulfilment."

The following case will show the position which the court took in regard to an unavoidable deviation in a contract for a block of stores. The contractors, during the erection of the stores, discovered that the city had given them the wrong grade for the sidewalk, thus raising the stores about 8 inches too high. They notified the architect and a representative of the owner, who made no objection at the time. A balance on the payment due on the final certificate given by the architect was refused because of the mistake in the setting of the building. The case was carried to the Supreme Court, which decided in favor of the contractors as follows: "As there has been no wilful departure from the terms of a building contract, nor any omission in essential parts, and the laborer has honestly and faithfully performed the contract in all its material and essential features, he will not be held to have forfeited his right to remuneration by reasons of mere technical, inadvertent, and unimportant omissions or defects." "A substantial compliance with the contract is all that is required to entitle the builder to his reward."

30. Determining the Responsibility.—Deviations from the agreement, due to the contractor's non-compliance with the specifications or drawings, are often held to be the direct cause of poor or insufficient construction, resulting in damage to the building and loss to the owner. Where such is the case, it often becomes the court's duty to fix the responsibility, which, should the damage be proven to have been due to the deviations from the contract, will very likely be placed upon the contractor, even though there were no objections to them by the owner.

The following is an illustration of such a case: A contractor bound by an agreement, supplemented by plans and specifications, erected, or partially erected, a frame church; it was nearly completed when a severe gale blew it down.

Subsequently, the contractor entered suit for the money due him; it was held by the owner that certain deviations were made from the contract which were undoubtedly the cause of the damage; the owner had, however, previously made no objections to the changes. The architect brought evidence to prove that the manner of construction in question, and from which the deviation had been made, was shown on the drawings, though there was no mention of it in the specifications. The evidence of the witnesses was rather unsatisfactory, as they differed in regard to the relative merits of the two constructions, also in their interpretation of the plans. The jury was instructed by the judge as follows: "If the contractors departed slightly from the plans, specifications, and drawings, and yet if such a departure did not diminish the strength of the building, nor contribute to its being blown down, such departure does not deprive them of their right to recover in this action, as the contract appears by the evidence to have been otherwise complied with." The decision was reversed, however, by the Supreme Court of Illinois, which said: "This position is untenable. The contractors had no right to depart from the working plans made part of the contract. If they did so, it was at their peril, and they would become guarantees as to the strength and safety of the structure." "The drawings were made part of the agreement. The contractors could only discharge themselves from liability by constructing the building in accordance therewith, unless a deviation was mutually agreed upon."

ABANDONMENT OF CONTRACT.

31. Reasons for Abandonment. — The abandonment of a contract occurs through the neglect of one or both of the parties to carry on the work for which they contracted. It may occur through the builder being unable to carry on the work, or the owner refusing to longer be a party to the agreement; or it may be that the interference of the law or some irresistible power prevented the fulfilment of the agreement. In any case, where the terms of the contract

are well defined and have not been mystified by many changes and modifications, the court will endeavor to enforce them, or such ones as may still be binding.

Should the work, when partially completed, be abandoned by the contractor, without cause, or without consent from the owner, and should the builder refuse to proceed with it, the courts will not allow him a claim. He would not only be unable to recover a reasonable price for the completed work, but would be liable for damages to the owner.

If, however, the owner accepted the abandoned work, and derived benefit therefrom by proceeding to complete the agreement under another contractor, the courts would be likely to hold that, upon the completion of the work and the final payment to the second contractor, the first contractor would be able to recover the balance, if any, existing between cost of the work as done under the second contract and the amount of the original contract, deducting, of course, any damages which the owner might have sustained by delays caused by the abandonment of the work.

32. Responsibility of Owner.—The owner instead of the contractor is often at fault in carrying out the agreement, and in such a case the builder usually has no cause to complain of his treatment by the law. Where the owner is delinquent in the fulfilment of his agreement, the contractor may present his case to the court in two ways. He may hold that the contract is still in force and claim compensation at the contract rates for the work that has been done, together with a claim for damages which resulted to him, due to loss of profit on account of the owner's delinquency; or he may claim that the contract has been abrogated, or annulled, and require reasonable payment for his work and materials furnished. Though he has either of the above paths to pursue in prosecuting his case, it is well defined by law that he cannot present evidence applicable to both, but must accept one or the other and hold to it. He should be governed as to his choice by the circumstances surrounding his claim, and the advice of his counsel.

In regard to a case where a contractor was prevented by the owner from proceeding with the contract, the New York Court of Appeals plainly stated the two grounds upon either of which a contractor could take his stand in presenting his claim; the opinion held by this court was as follows: "Where performance is prevented by one party to a contract, who terminates the agreement against the will of the other party, the latter may either sue for breach of contract, and recover as damages the profits he would have made if allowed to complete the work; or he may waive the contract, and bring his action on the common count for work and labor generally, and recover what the work done is actually worth; but in this case he cannot recover his profits on the unexecuted part of the work."

The owner may abandon his contract by failing to live up to his agreement, or he may prevent the contractor from carrying out the work, and fulfilling the agreement. Such a case as this was decided in Indiana. The owner of a building in course of construction having failed to pay the instalments on the work at the several periods when they were due according to the contract, was sued for damages by the contractor, who claimed he had to abandon the work because of the non-payment of the instalments. The court's opinion in the matter was somewhat to the effect, that if the owner had really prevented the contractor from fulfilling the agreement, then he should be able to recover, as damages, the profits that would have accrued to him, providing he had completed the job; but that the mere non-payment of instalments due on the contract before the work was finished, did not constitute such prevention.

There are numerous other instances where it has been held that the contractor was unable to fulfil his part of the agreement on account of the owner failing in some way, either avoidable or unavoidable, to live up to the contract. In all such cases, it seems to be the opinion of the courts, where it can be proven that the contractor was willing and ready to comply with his part of the agreement, and was prevented by the owner from doing so, that he is entitled to

recover, not only for the actual work done, but also for any profit which he would have received upon the completion of the contract. For instance, should certain ironwork be ready for a building at the stipulated time, and should the building, which was not in a condition to receive it, burn down, the parties furnishing the ironwork would undoubtedly be able to recover the contract price, less the cost of erection; for they had completed their agreement as far as it was possible, within their power, to do so; further completion being impossible, owing to the failure of the owner to have his building ready in time.

33. Death of Either Party.—Death of the contractor ends the contract, unless some provision is made in the agreement by which his heirs or executors become responsible for its completion, and it has been decided by the court in Missouri that no lien can be taken out against the building for work or materials thereafter furnished under the contract. The contractor seems in this case to have the advantage, as the death of the owner does not affect the contract, because it is binding against his estate.

Where the contracting parties wish to guard against any of the above mentioned contingencies, all that is required is the insertion of a clause in the contract which will convey their mutual intent and meaning in regard to the matter considered, and the court will see that it is enforced irrespective of general principles and precedent.

34. Abandonment Not Always Justified.—The contractor, before taking so serious a step as the abandonment of a contract, should be sure of his position, and determine whether he is justified in such a proceeding; for, as the Supreme Court of Missouri expresses it, "a mere breach of contract does not entitle the other party to stop work and recover for unperformed work. He might stop work and recover for what he has already done, but not for what remained to be done. To recover for that, he must have been prevented from going on by the unauthorized interference of the other party. The measure of damages on the

contract, in such cases, is the contract price, less what it would cost to complete the work."

35. Forfeiting of Contract.—It sometimes occurs that one of the parties of a contract may find it impossible, owing to the conduct of the other party, to fulfil the terms of the agreement. In such a case he should notify the other party immediately, declaring his unwillingness to be bound by the contract, or at least by certain stipulations in it; if he fails to do this promptly, it may be held that by his silence he waived his right to do so. For instance, a contractor may have been unreasonably delayed and interfered with by the owner's demands requiring a number of changes, or by the owner's withholding his decision on certain important questions, which prevented the contractor from proceeding with the work and completing it in the specified time. This being the case, the contractor is entitled to rescind the agreement, but he should do so at the time, or it may be held that he has waived his right to do so.

Instead of the owner being at fault, the contractor may fail to have the building finished at the stipulated time. This might give the owner the power to rescind the contract, but he should exercise this right at once; for should he fail to do so, and permit the contractor to proceed with the work, it would very probably be held that he had waived his right, and all he could claim would be damages, as provided in the contract, for injury due to the delay caused by the failure of the contractor to complete the agreement at the specified time.

The contractor, before entering upon an agreement, should ascertain whether the plans and specifications call for work that can actually be constructed, and whether the conditions are such that they can be carried to completion. Anything that is not clear to him from the plans or specifications, should be explained by the architect to his satisfaction; otherwise, if he should find, after signing the contract, that he cannot in any possible way carry out the work as shown, the court will very likely hold that he, being a

responsible builder, should have known whether the plans could be carried out, and that he was bound by the contract.

36. Reinstating Contracts.—Any contract that has been declared forfeited under the terms of the agreement, may be reinstated by the mutual consent of the parties concerned; in which case they will no longer be governed by the annulment.

FRAUDULENT CONTRACTS.

37. "Statutes of Frauds and Limitations."—In the several states, there are codes of special laws which are known as the "Statutes of Frauds and Limitations." The particular clause in these statutes of interest to those engaged in building operations, is here quoted from the statutes of Maine and reads as follows: "No action shall be maintained upon any agreement that is not to be performed within one year from the making thereof." That is to say, no contract shall be valid (unless in writing) that calls for an accomplishment of certain things that cannot be fulfilled in one year from the date of making the contract. The decision of a New Hampshire court is interesting in that it held, that if the performance of the contract could be accomplished within a year (even though it was improbable that it would), the contract was not within the statutes and did not have to be in writing. The language of the court in this case was: "The Statute (of Frauds) does not apply to any contract, unless by its express terms, or by reasonable construction, it is not to be performed—that is, is incapable in any event of being performed—within one year from the time it was made. If by its terms, or by reasonable construction, the contract can be fully performed within a year, although it can only be done by the occurrence of some contingency by no means likely to happen, such as the death of some party or persons referred to in the contract, the statute has no application, and no writing is necessary. If the agreement can be fully performed by either of the parties within one year, and it is so performed, the agreement of

the other party is not within the statute, though it may be impossible to perform it within a year."

A case once arose in New York where the question involved was as to whether the terms of a verbal agreement prevented the possibility of the contract being completed in one year. The contract was made about fifteen months before the date upon which it was verbally agreed that the building should be completed. Some misunderstanding in regard to the agreement arose, and, in the suit which followed, the defendant claimed that the contract was invalid under the "Statute of Frauds." The claim was, however, denied by the statement of the Supreme Court, which rendered the following decision: "The agreement set forth in the declaration in this case is not for the building of a house after the expiration of one year, but is to be performed at the farthest within fifteen months. There is nothing in the agreement prohibiting the defendant from completing the contract within six months, or a shorter period. Suppose he had done so, and sued the plaintiff for compensation for his labor and materials found, would it have been permitted to the plaintiff to have said that the contract was not to be performed within a year, and therefore it was not obligatory on him? Most clearly not. And if obligatory on one party, it is equally so on the other. The defendant might have performed the contract within a year, and it is therefore not within the statutes."

38. Fraudulent Contracts.—It is generally supposed, that where a man has signed a contract he is held responsible, and there is no escaping its conditions. However, if it can be proved that fraud was used in gaining the signature of the party, or that he was wilfully deceived in some manner, the court will deal fairly with him, and, as far as possible, will usually prevent the fraudulent party from gaining an advantage; for the court fully realizes that, no matter how carefully a man may conduct his business transactions, no amount of care will protect him against frauds. The court, however, will have little patience with any one who,

through carelessness, allows himself to be imposed upon. Even in cases where no fraud is intended and a mistake exists, if it can be proved that no usual amount of care could guard against it, the law will make an effort to correct the mistake and release the innocent parties, if it can be done without dealing unjustly with the other parties, who may have been more careful.

When a party discovers, before commencing the work, that he has entered into a contract which misrepresents the amount of labor he is to perform, or materials to furnish, he should, in order to avoid trouble, notify the other parties immediately, that he repudiates the contract. If he should proceed with and perform the work, knowing that the amount to be done had been misrepresented to him, he would be unable to obtain more than the contract price. It has also been held, where a stipulation in a contract, such as the time of completion, is misrepresented, or a mistake in the statement has been made, that the balance of the contract remains intact, and that only such parts as are affected by the erroneous stipulations are invalidated. A contract made on Sunday is invalid.

COMPLETION OF THE CONTRACT.

ACCEPTANCE OF THE WORK.

39. Completion of Work.—The last, or final, stage in the fulfilment of a contract is the completion and acceptance of the work, which is often fraught with more misunderstanding and dispute than any other portion of the transaction.

Most contracts stipulate that the work shall not be deemed as completed until it has been accepted by some designated party, which is usually either the architect or the owner. If the architect accepts the work he should furnish a certificate to the builder to that effect. Should the owner be the one who accepts the work, he should do so in writing. In

some cases it is required that both the architect and the owner should accept the work. It is well to stipulate in the contract that all work shall be subject to the approval or satisfaction of the specified architect or architects. This clause is valuable, in that it leaves all unsettled matters in regard to workmanship and materials to his decision, and sustains his authority as a final judge. If his judgment has been given in good faith, and with an intention to deal fairly with both his client and the contractor, there will be no necessity for subjecting the controversy to settlement by arbitration or trial by jury; for the court nearly always accepts the opinions and decisions of an honest and conscientious architect.

Where it has been stipulated in the agreement that "the work shall not be considered complete until certified to by the architect," it will be held by most courts (though there are exceptions to this rule), that the contractor must present a certificate from the architect before he will be able to claim that the contract has been completed. Even though the contract especially stipulated that the architect's certificate was to be binding and conclusive upon both parties, such is not always the case; for, if it can be proved that the architect fraudulently or unscrupulously withheld it, or, in failing to grant it, he was not acting according to his best judgment and was prejudiced against the builder, intending to oppress him, the court may hold that the architect's certificate is not necessary to the completion of the contract.

The architect is always subordinate to the contract. He cannot cause work to be done at variance with the stipulations in the contract; neither will his certificate for work that does not fulfil the requirements of the agreement be valid, and, though he has the power by the terms of the agreement to reject or accept all work as he may see fit, he is not authorized to reject any work that is done according to the agreement, nor accept that which is not.

40. Accepting the Work.—The acceptance of work by either architect or owner is not always a waiver of the

defects that may exist in it; though it may sometimes be implied from the owner's conduct, where the defects have been obvious and he has made no objections to them, that he accepts the work. But, should the defects be concealed, neither his virtual nor formal acceptance will prevent him from recovering, on the grounds that the contract was not completed. In regard to this the following view is generally taken by the courts: "Notwithstanding acceptance, virtual or formal, unless expressly made in full discharge of the contract, if the work or materials are not as contracted for, the owner may recover damages sustained in consequence."

A case involving this principle occurred in Georgia about the year 1854. It seems that a contractor undertook certain work for the trustees of a university. The contract was made in regard to some repairs and the remodeling of a certain building. It was required that the contractor should "remove certain walls and put in such pillars as might be necessary to support the ceilings"; also, that the work should be completed "in a neat and workmanlike style." The repairs and alterations had been completed and virtually accepted by the trustees, who were present during the time the work progressed, and had made no objections to it. About eighteen months afterwards, one of the wooden girders that were put in under the contract, failed, and so injured a portion of the ceiling that extensive repairs were necessary. In the suit instituted by the trustees for damages, testimony was introduced by the defendants to the effect that several days previous to the accident a leak had been discovered in the roof, and that the leakage so increased the weight upon the girder, as to cause it to fail. The plaintiffs proved, however, that the chestnut girder was of a brashy nature and knotty, and further expert evidence was introduced to prove that it was of insufficient strength and ought to have been supported by several more posts.

41. The Right to Recover.—The lower courts decided in favor of the defendants, but the decision was reversed by

the Supreme Court, which held "that the plaintiffs received the work, and paid for it, does not affect their right to recover in the slightest degree; it is not a circumstance to be considered against that right. They are entitled to recover, unless they, at the time of the acceptance, knowing of the defective and neglected work, and of the non-compliance by the defendants with their contract in all respects, expressly waived a performance of the contract, and agreed to pay the stipulated prices, notwithstanding; all of which must be made affirmatively to appear by the defendants, to be available to them as a defense. . . . The evidence in this case falls very far short of this. Was the attention of the plaintiffs called to the fact that an important girder was brashy, knotty, and entirely incapable of supporting the weight resting on it? . . . Their attention was not called to it, and they could not see and examine the girder for themselves, for it was concealed from their view by the floor on one side and the overhead ceiling on the other." One of the claims of the defendants was, that the insufficiency of the pillars was self-evident, and that the plaintiffs must have observed the defect. In reply to this, the court said: "True, they could see the number of pillars, but they were not informed as to the number necessary. The defendants undertook specially, in their contract, to put in 'such pillars as might be necessary to support the ceiling'; they were to judge, and to judge correctly, at their peril. . . . The idea that they (the plaintiffs) were waiving any of their rights under the contract, never entered their minds; . . . they accepted the work because they believed that the defendants had complied."

42. Occupancy or Possession.—It is generally understood among builders that the owner, by moving into or occupying the building constructed under the contract, implies an acceptance of the work. Such, however, is not always the case, as many decisions of the courts show. Even should he pay the contractor in full without demanding

the architect's certificate, or otherwise formally accepting the building, it could be held that no implied acceptance was meant.

In a case where a contractor had failed to comply with some material part of the contract, the parties for whom the work was done moved into the building and refused to pay the balance due the contractor; the contractor entered suit on the ground that the parties, by occupying the building, virtually accepted the work. It was held, however, by the New York Court of Appeals, "that if a contractor has neglected, and refuses, to complete his contract in a material point, it does not follow that the owner waives its performance by taking possession of, and occupying, the building in its defective condition." The court also said: "An owner is not put to so absurd an alternative as either to lose and abandon his building, worth perhaps ten thousand dollars, or to occupy it at the peril of paying for work not performed, or of waiving thereby the performance of any substantial covenant of the contractor." The New York courts also hold that: "The occupancy of a building is not a waiver of the plain requirements of the contract."

PENALTIES AND PREMIUMS.

43. Liquidated Damages.—The owner is often put to considerable inconvenience, and in some cases needless expense or loss, by the delinquency of the contractor to have the work finished at the stipulated time. For instance, it may be that the parties are erecting the building for their own occupancy, and that the lease upon the property which they are occupying expires about the same date as that on which the contractor is to have the building completed; or it may be that the new building is to be rented to tenants who expect to occupy it by a certain date, and have made arrangements accordingly. Hence, it is evident that the owner or owners may be placed in a very awkward position, and compelled to sustain considerable financial loss, entirely

due to default of the contractor in not having the work completed on time.

To guard against such a contingency, it is usual to provide in the contract, that the person doing the work shall pay a certain sum of money per day to the owner, for each and every day beyond the stipulated time of completion that the work may remain unfinished. It is generally specified in all contracts that this stipulated sum of money or forfeiture shall not be regarded as a penalty, but is to be considered as liquidated damages (the term, liquidated damages, simply meaning damages that are fixed by the terms of the contract, as opposed to unliquidated damages, which are decided upon, subsequently, by jury or other means). The Supreme Court of Alabama, in regard to such forfeitures, says: "The court must ascertain whether the true intention of the parties was to afford fair and reasonable compensation for the loss sustained, in which case it is a real penalty, which can be apportioned to the actual loss sustained; or liquidated damages, which must be suffered without regard to actual injury resulting from failure to keep the contract. The tendency of the law is to regard the stipulations as a penalty, rather than as liquidated damages, and, if there is any doubt as to the intention of the parties, it will be so construed; and even if the stipulation is for payment of a sum in gross in case of failure to perform, the sum stated will still be considered as a penalty." It would seem from this decision that there is a difference expressed between a penalty and a forfeiture for liquidated damages. A penalty is regarded merely as a sum to be forfeited, out of which the actual damages are to be taken; while liquidated damages are a sum usually agreed to by the contracting parties, as the amount to be considered as actual damage. The purpose in regarding the forfeiture as liquidated damages is to avoid subsequent dispute as to the amount of the real loss suffered by the owner; and it is commonly thought, where it is expressly stipulated that the forfeiture is to be considered as liquidated damages, that the courts would not interfere to invalidate the valuation which the parties had mutually agreed to in the contract.

44. Just Compensation.—Many of the highest courts in the land, however, look upon all time forfeitures as mere penalties, out of which the actually ascertained damages are to be taken, whether they are stipulated as liquidated damages or not. In such decisions the owner is entitled to only such a sum as would fairly represent the loss he had sustained, and no reasonable forfeiture could be collected.

Should it be proved that the owner endeavored to make profit out of a forfeiture clause, even though the forfeiture each day was qualified by the phrase, that it was to be considered not as a penalty but as liquidated damages, it is more than probable that the court would not uphold him, and would decide, as previously stated, that all he was justly entitled to would be damages amounting to the actual loss he sustained by the default of the contractor. This was decisively settled by the Supreme Court of Michigan, which formulated the following rule: "The principle at which the law aims in awarding damages is that of just compensation for the injury sustained; and the parties will not be permitted by express stipulations to set this principle aside."

Even should there be no stipulation in the contract to the effect that the contractor was to forfeit a certain sum as liquidated damages for each and every day the work should remain unfinished beyond the specified time, the owner would be able to recover, as damages, any loss he could bring evidence to prove actually existed through the default of the contractor.

45. Extent of Contractor's Responsibility.—The following assumed case will illustrate somewhat to just what extent the contractor is responsible, in regard to the forfeiture clause in contracts. An owner contracts with a party for the erection of a summer cottage, and stipulates in the contract a reasonable forfeiture, to be paid by the contractor, provided it is not completed on time, thinking that in this manner he will stimulate the builder to an extra effort. The builder fails to have the cottage done on time, and suit is entered by the owner for the amount of the

forfeiture, which is out of all proportion with the importance of the job. The court will very likely hold that he can recover only the day rent of the cottage for each and every day over the specified time, provided the delay has not been serious; and if the time of completion has so far exceeded that specified, that the owner has been compelled to abandon the cottage for the summer, they will more than likely award him damages to the amount that would be required to rent a similar cottage for the season. Again, it may be that the building is to be rented, and for every day over the time specified that the builder fails to have it completed, the owner is out just so much rent; in that case the court will award him the amount that he has lost in rents, with any other loss he may have sustained through invalidated leases with the tenants. Therefore, since it is very generally accepted by the courts that in any case only just damages can be recovered, the best thing that the owner or architect can do in stipulating the terms of the contract, where it is important that the work should be completed by a specified time, is to carefully estimate, as nearly as possible, the actual damage that will occur from the non-completion of the contract, and to add to this a reasonable margin for unforeseen contingencies. This amount should be obtained in a sum of so much a day, and inserted in the contract as a forfeiture clause for liquidated damages, and, were disputes to arise, would be upheld by the law if it is reasonably correct.

46. Unfinished Work.—The stipulation providing that a forfeiture shall be paid for delay in the completion of the building is of some advantage to the contractor; though, at first sight, it might not appear so. This advantage is due to the fact that, as a stipulation is made in regard to the forfeiture of a sum of money for each day that the work shall have been delayed beyond the contract time, and such a forfeiture is agreed to by the builder in signing the contract, the owner must necessarily waive his right to rescind the contract on the ground that the work was not completed on time. If, however, no such forfeiture clause exists, the

failure of the contractor to have the building finished in the specified time is a breach of the agreement, and the owner may rescind the contract. Thus the builder or contractor loses his final payment for the unfinished portion of the work. Should the owner, however, fail to notify the contractor of the termination of the agreement on the day specified for the completion of the work, and allows him to proceed with the job, he cannot do so subsequently, as he has waived his right in this direction. The courts have ruled in regard to this, that "when the owner permits the contractor to continue work after the expiration of the time within which the work was to be completed, he waives the right to rescind the contract on that ground, but does not thereby waive such damages as he may have sustained by reason of the delay."

47. "Reasonable Time."—When no specified time for the completion of the work has been provided in the contract, it might be supposed that the contractor could dawdle over his work indefinitely; such, however, is not the case, for it is presumed that a reasonable time is always understood, though just what constitutes a reasonable time is a little uncertain, and will depend upon the jury before which the case is tried. It would not be safe, therefore, where there is no time stipulation in an agreement, for a contractor to delay very considerably the completion of the work; for, should the owner's patience fail, and he bring suit, the jury is likely to decide that the contractor had been allowed more than a reasonable time for the performance of the work, and the owner could recover damages for the delay over the time held by the jury as being reasonable.

Should the owner waive the stipulation in regard to the time of completion, or his claim for damages due to the delay, or any other stipulation or clause, it must not be thought that the other provisions in the contract are waived, or that the contract is invalidated thereby. Such is not the case, and it may be expressly stated that the waiver of one stipulation of a contract does not affect the others.

48. Delays.—It is not unusual for the contractor who has agreed to have the work completed by a certain date, to be delayed, and thus prevented from complying with the contract, through the fault of other contractors or of the owner. Where the delay has been caused by the default of other contractors, it seems to be held as a rule, that the contract is subjected to implied modifications in regard to the time limit; an extension of the time being allowed to the principal contractor, equal to the delay caused by the other's, fault. This is substantially the same as was held in Illinois when the court stated: "Where one contracts to do certain work in such a way as not to delay other contractors, and to have it done on a certain day, and, by delays of other contractors, is unable to commence it until near the time of completion, he is still held to the contract, except as to time of completion, and for unnecessary delay on his part will be liable to his employers for damages."

Should the delay be caused through the fault of the owner, the contractor will not only be entitled to an extension of the time limit, but should he on the same account be put to additional expense, he will be able to hold the owner for such; unless it is provided in the contract that the owner shall have the power to postpone or delay the work as he may see fit. When, however, the contractor finds that the owner or the other contractors are causing him delay and additional expense, he should notify the owner to that effect immediately, so that the owner can take steps to prevent the delay, or so enjoin the other contractors that they will remove the cause of the complaint, and hence the additional expense to the complainant.

49. Non-Fulfilment of Contract.—The owner, upon finding that the work is not progressing rapidly enough, due to neglect or inability on the part of the contractor, may, upon giving due and proper notice to that effect, employ other parties to finish the contract, and in due justice to himself may, in order that he will not lose the advantage of the contract, pay these parties out of the contract

price, or charge the cost to the original contractor. It is usual, in carefully written contracts, to provide in some manner for this contingency, and to make special provision in regard to the terms and circumstances which will authorize the owner in taking such a step. The rights of the contracting parties in regard to this are clearly expressed in the following decision of the Supreme Court of Illinois: "If one party induces the other to believe that he has withdrawn from the contract, the other need not wait for the day of performance before making new arrangements, nor does he lose his remedy against the delinquent party by providing at once against losses likely to arise against such delinquencies."

The owner, in taking the work out of the delinquent contractor's hands and completing it himself, or through another contractor, must see that it is done within a reasonable expense. In fact, since the original contractor has to pay for the subsequent work, it is really his money that is being used, and the owner should guard it as he would his own, avoiding extravagant or wasteful expenditures; for, should it be proven that he was careless in this respect, and attempted to charge an unreasonable sum against the original contractor, the courts will not uphold him. The owner may, if he deems it advisable, complete the building by day work, or he may make arrangements with another contractor to do so at a reasonable price; but he must keep careful account of the actual expenditures, and charge nothing else against the original contractor.

Should the owner, after rescinding the contract according to the provisions in it, or upon good and sufficient reasons, find that some of the original contractor's work is defective, he may make good such work, and charge it to the cost of completing the building. If there are materials upon the site of the new building furnished by the original contractor, and these materials are good in every respect and substantially as specified or contracted for, the owner is bound to use them in completing the work, and thus avoid charging the original contractor the cost of such materials, that may be of less or no value on other work.

In well drawn contracts, however, provision is generally made that where the contract is forfeited, and materials are left on the ground by the original contractor, they shall be used at the discretion of the owner or architect.

Even where the contract has granted them the authority, the owner, and the architect as well, should carefully consider the circumstances, and all of the stipulations relating thereto, before taking so serious a step as the forfeiture of a contract. Where no provision has been made in a contract with regard to the contingency of its forfeiture, the owner or architect, as the case may be, should, when he has good reason to do so, notify the contractor that he has forfeited his right to complete the contract. He should also endeavor to show an intention of finishing the work, according to the terms of the contract, at a minimum cost to the original contractor, and protect his interest in every possible way.

50. Terminating a Contract.—An architect was once authorized in a contract to terminate it if he should see fit; the contractor applied to court for a decision as to whether the architect had a right, under the circumstances, to forfeit the contract. The architect held that he had the right to declare the contract forfeited, under the terms of the agreement; but the court decided that the contractor had the privilege to apply to the court for their decision as to whether the architect was justified in terminating the contract.

The termination of the contract, and the completion of the work by the owner or his representative, somewhat changes the position of the architect. A New York court held, in a case where a subcontractor had entered suit and the work was being finished by other parties designated by the owner, who had rescinded the original contract, that the certificate of the architect, which was required under the original contract before payment would be made, was not required as the owner was now his own contractor.

51. Premiums.—Premiums are sometimes offered where the work is of special importance, and are stipulated in the contract as being payable to the contractor at so much

a day for each and every day that he shall have the work finished before the stipulated time. Where such premiums are stipulated in the contract and the owner in some way unreasonably delays the work, thus preventing the contractor from completing it before the stipulated time, and depriving him of the premium, it has been held that he can recover, provided it can be proved that he would have finished before the time specified, if the owner had not interfered.

The difficulty, however, in such cases is in determining just how long before the stipulated time the contractor would have finished, provided the owner had not interfered. This at best is mere guesswork, and depends upon the circumstances surrounding the case. Where the stipulated premium amounts to a considerable sum of money for each day gained, it can readily be seen how important it is to determine correctly the exact number of days. For instance, in one case the stipulated premium was $500 a day for each and every day the contractor should have the work completed before the specified time; the owner interfered, and the contractor entered suit, claiming that without such interference he would have gained considerable premium; the court decided that he could have finished 30 days before the stipulated time, and awarded him the $15,000 due him.

EXTRA WORK.

52. Extra Work: Verbal Understanding.—In a case brought before the Superior Court of Massachusetts, where the written contract stipulated that no extra work would be paid for unless ordered in writing, and where the contractor had done extra work on verbal orders and been refused payment, the court held that "attempts of parties to tie up by contract their freedom of dealing with each other are futile. The contract is a fact to be taken into account in interpreting the subsequent conduct of the plaintiff and defendant, no doubt, but it cannot be assumed, as a matter of law, that the contract governed all that was done until it was renounced

in so many words, because the parties had a right to renounce it in any way, and by any modes of expression they saw fit." In expressing the above decision the court was undoubtedly governed by the facts of the case, which were that most of the work was done after the original contract was practically completed, and the extra work, which was done during the completion of the original contract, had been verbally agreed to, and payment promised for the same. Hence it seems that the point to decide was not so much the setting aside of the stipulations requiring all extra work to be ordered in writing, as it was whether the stipulations in the original agreement applied to subsequent and apparently independent work.

A similar case came before the Federal Court, where suit was entered by a contractor to recover payment for extra work, which the government had refused because it was stipulated in the contract that no extra work should be paid for unless agreed upon in writing. The court held that such a clause was inserted by the government in order to limit the powers of the architect and superintendent, and did not bind the parties in such a manner as to avoid a verbal or implied agreement for extra work. The judge further stated: "Courts cannot transmute a contract into a statute of frauds, nor attach to the agreement of the parties the irrevocable mandatory attributes of a statutory provision. A provision in a written contract declaring that no claim for extra work shall be made unless it was required and agreed upon in writing, is merely a condition, which may be waived by a subsequent oral agreement." Also, "Where a public agent requests a departure from an express contract, and the change ordered is of such a nature that he may reasonably suppose that no additional expense will be caused thereby, the contractor is bound to speak, or he will be deemed to have consented to make the substitution at the contract rate. But where the change is of such a nature that it must necessarily involve additional cost, no such notification is necessary, and the contractor will recover reasonable compensation."

It would not, however, be safe to omit the clause in the contract which provides that "no extra work shall be paid for unless ordered in writing," for it has been held by many courts that such a clause cannot be broken with impunity; and where it can be proved that the real intention of the parties concerned was that all such orders for extra work should be made with due formality, the contract is valid and will be upheld by the court.

53. Extra Work: Written Agreement.—Often there is found in the contract two apparently contradictory clauses: one that implies that no extra work shall be paid for unless ordered in writing, and another which states that the engineer or architect shall have power to direct additions to, or alterations in, the work. The court has decided, however, that in such cases the latter clause does not in any manner affect the validity of the first. A New York court refused to admit evidence where the contract provided that "no extra work shall be paid for if not ordered in writing," unless the parties could furnish the written orders for such work.

In emergencies where the safety of the building is at stake, and the architect or the engineer may deem it necessary to verbally order extra work done, to eliminate such danger, the contractor would more than likely be able to recover payment for the extra work, even though there was a stipulation in the contract that written orders would be required for all extra work. In order to illustrate in what light such a condition of affairs is held by a court, the following may be of interest: A county commission in Indiana appointed a supervising engineer to superintend the erection of a certain bridge to be built under contract. During its erection the superintendent thought it advisable to do the work in such a manner that a considerable amount of extra masonry and filling was required. The contractor, being unable to collect for the extra work, entered suit. The county commission claimed that the county could only be bound by the contract, and were responsible for nothing outside of it. The case was carried to the Supreme Court, which based its decision

upon the statutes applying to the erection and repair of bridges, which set forth that "for the erection of any such bridge, the said board shall appoint one or more discreet persons as superintendents thereof," and further authorized that the superintendent should have the power to receive proposals, let contracts to the lowest responsible bidder, and require surety for the performance of the agreement. On this the court found that "it is thus seen that the superintendent has power to let contracts for the construction of bridges, and to superintend the work. We think that this makes the superintendent the agent of the county for the purpose of the construction of the bridge or bridges, and that he may bind the county by requiring work to be done beyond that contemplated by the contract. Such authority in the superintendent is necessary for the county, in order that the structure may turn out to be substantial and lasting; and it is proper, in order that the contractor employed to perform the extra work may have a remedy therefor. If it should be foreseen by the superintendent, after the letting of the contract, that the work performed or contemplated by it would be insufficient or defective, the county might be greatly the loser if he could not require such additional work as would make it substantial and permanent, and bind the county therefor." It should be distinctly remembered, however, that unless the contract expressly stipulates that an architect has power to order additional work, the owner will not be held responsible for payment for such work, unless, as stated in the preceding paragraphs, it is absolutely necessary for the safety of the building and well being of the owner. In such a case the court, if passing favorably upon it at all, will very likely do so on the basis that the architect acted as the owner's agent, and as such had authority in an emergency to order such extra work to save the owner from loss, and hence the owner would be required to pay for such work.

54. Advantage of Observing Extra-Work Clause.— It would be better for all parties concerned if the contract,

which expressly states that there shall be no extra work done unless ordered in writing, was lived up to, for if such a stipulation is once broken, it is likely that carelessness in this respect will become the rule rather than the exception during the whole of the building operation, and when the settlement comes to be made there is trouble for both the owner and the contractor. It may readily be understood how, during a large building operation, where there is looseness in carrying out the contract stipulations for orders for extra work, there may be numerous misunderstandings in regard to the various verbal orders given. These misunderstandings frequently arise from the fact that, in the hurry and bustle of a modern building operation, the average contractor is likely to interpret the slightest wish or action of the owner as implying an order for extra work, and as the operation proceeds, the careless owner continues to express his wishes for the most trivial variations, not realizing that the possibly unscrupulous contractor is carefully keeping account of all such suggestions and figuring on collecting a good price for them, as orders for extra work. Thus it is that when a contract is broken, in whole or in part, it is difficult to enforce it again. In making the final settlement, the owner is often inclined to admit that certain of the verbal orders were valid, but to claim that others were not, because of no written order being furnished. This very contradictory condition of affairs is obviously unjust, and would be looked upon with disfavor by any court, which would be likely to decide, as in a New York case, that "a written contract may be waived, either in whole or in part, by parol, and after it has been thus waived by one of the parties, neither he nor any one acting under him can reinstate it."

55. Estimating Charges for Extra Work.—Contractors, in estimating the amount to charge for extra work, are apt to base their estimate at day wages; hence it would be well to stipulate in the contract, either that all extra work shall be paid for at contract prices, or furnish some schedule upon which the charge for extra work may be based. When

the extra work is of the same nature as that specified in the contract, it is usual to itemize the estimate from which the contract has been made up, and to charge all extra work accordingly. Usually when this is done the itemized schedule is affixed to the contract, and agreed to by the parties concerned, as the basis upon which all extra work is to be charged.

In a like manner to that in which extra work is ordered, omissions are sometimes made from the work required by the original contract. Where this is done, the amount of the deduction to be made from the contract price, on account of the omitted work, should be immediately agreed upon with the contractor, and he, in deciding what will be a fair price to allow, must be governed by any stipulation bearing on the subject in the contract, and must also, if he wishes to deal honestly with himself, take into consideration any cost that may be caused by such omissions, which should be deducted from the allowance to be made to the owner.

Where no stipulation in regard to allowances for work omitted is made in the agreement, the views of the courts are very changeable as to whether the owner is entitled to any deduction. One court has handed down an opinion, that "the defendant (meaning the owner) had a right to demand the very work specified, and if it accepted anything less as sufficient for the purpose named, has no right to insist that a rebatement should be made for that reason"; whereas another court has held, that "the owner is entitled to a reasonable compensation for work which has, by his desire, been omitted." It is evident, then, that it would be well, and more satisfactory to all parties concerned, if stipulations were made in the agreement in regard to deductions to be made from the contract price for work omitted, and upon what schedule the prices by which the value of such work is to be estimated.

56. Decision as to Estimating.—A case often comes before the court that requires a decision as to how work shall be estimated. In such cases the court is generally guided by

the local custom in figuring such work, provided that this custom is well established among people engaged in building operations, generally understood by them, and reasonable in its results.

The Supreme Court of Missouri is agreeable to the custom which provides that in estimating for the laying of *stonework;* the door and window openings shall be measured as solid, and the corners measured twice. This same view is held in Maryland, with the further provision in regard to curved work, which should be measured at one and one-half times its actual length. However, on account of the widely differing customs that sometimes exist in the same state, too much dependence should not be placed upon the legal validity of any one of them.

57. Plaster Work.—A New York court once admitted evidence to prove that it was the custom among plasterers in Buffalo to charge for the entire surface of the walls, without making any deductions for the window and door openings, cornices, or baseboards. A Pennsylvania court took another view of such work by saying: "A custom of plasterers to charge half the size of the window openings, at the price agreed upon for the work and materials, is unreasonable and bad."

58. Brickwork.—Disagreements have arisen where brickwork was to be paid for by the thousand "in the wall," as to the method of counting the number of bricks, and, though the custom of allowing from 20 to 22 new bricks to a cubic foot of wall, or to a superficial foot of 12-inch wall, is well established among masons and bricklayers, the Supreme Court of Tennessee, in deciding such a case, would not admit it as evidence, and seemed to favor the actual count of the number of bricks used.

59. Excavating.—Before a contractor makes an agreement to do "earth excavation" at so much a cubic yard, it behooves him to ascertain the nature of the soil, as otherwise he may be disagreeably surprised to find that the bulk of it is through hard pan, which will cost much more to move

than ordinary earth, and which he did not figure on. If he should appeal to the court in an attempt to collect payment for the greater amount of work involved, he would more than likely find that his claim would not be sustained. Such a case was settled by the New York Court of Appeals, which decided that "earth excavation" included hard pan. A similar case arose in which an unfortunate contractor, who had failed to examine the nature of the soil carefully, agreed to excavate and back fill a ditch, at what would have been a very low figure even for earth. The contractor subsequently found that considerable of the excavation was in hard pan, and in some places rock. The contractor commenced suit for the extra cost of the excavation, but the court would not admit evidence to prove the additional cost of the excavation, and said "it was the duty of the contractor to have ascertained the nature of the soil before entering into the contract; ordinary intelligence would have enabled him to do so."

60. Using Sand From Premises.—Sometimes a stipulation in the contract provides that "sand taken from the premises shall be used in the masonry." A New York court decided in a case of this kind, where the work was found defective on completion, due to the unsuitableness of the sand used, that the owner had no redress, though there was nothing in the report of the court to determine whether or not the contractor had notified the owner, while the work was under way, that the sand was not suitable. It would, however, be good policy on the part of a contractor to notify the owner in a similar case.

61. Quality of Materials.—It is not unusual in contracts to find that the quality of many of the materials to be used is not specifically stated. A New York court has decided that it is implied that they shall be of fair quality, or at least they shall be sufficient and adequate. The decision of the court, as published in a law journal, is as follows: "In every contract for the furnishing of the materials, and

the performance of the work, in the absence of special provisions, there is an implied agreement on the part of the party who is to perform the work, and furnish the materials, that they shall not be of an insufficient and inferior description and value, and that the work shall not be totally inadequate to answer the purpose for which it was undertaken to be performed; and, though the agreement was that a specific sum should be paid for the work and materials, the claim may be reduced by showing that the work and materials were of an insufficient description and value, or it may be wholly defeated by showing that they were totally inadequate to answer the purpose for which they were to be furnished."

In regard to the stipulations in a Colorado specification that the "best lumber" should be used in a building, the Supreme Court decided that it meant the best that was ordinarily used in constructing buildings in that locality.

62. Old Materials.—A New York court, in regard to the ownership of old materials, said: "If the owner of land covered by houses, enters into a contract for the erection of other buildings on the same land, and does not provide for the use of the materials of the old building in the new, or does not remove them before the contractor takes possession under his contract, he will waive the right to them, and they will belong to the contractor."

63. Estimating Quantities.—The architect sometimes, though it is not usual for him to do so, prepares a bill of quantities of the material and labor that will be required in the construction of a proposed work. The contractor, however, should look with caution upon such an estimate, even though the architect should assent to its correctness, and should verify for himself any such bill of quantities, unless, of course, the contract is simply for the execution of such a bill of material, instead of the erection of the building complete; for should the contractor base his agreement upon this bill of quantities and afterwards find that the actual

amount of material and labor required exceeded the estimate, he would very likely find that nothing could be recovered through the courts.

Even in England, where the profession of "quantity surveying" is practised to some considerable extent, and independent of the architect, the courts have held, time and time again, that no such estimate of the work was a guarantee, and that neither the quantity surveyor, architect, nor owner were responsible for its correctness. Hence, it would seem that it was unnecessary for the architect to prepare any such bill of material, as the courts seem to be of the opinion that builders, as a rule, understand their business, and are capable of making their own estimates, and should be responsible for them, provided the extent of the work is clearly stated to them by the architect or owner, through the plans or specifications prepared for the building.

RESPONSIBILITY AND RISK.

BUILDER'S RESPONSIBILITY.

64. Safety of Building During Construction.—The responsibility for the safety of a building during its construction usually devolves upon the contractor, as has been decided in numerous cases. In a case where a contractor had entered into an agreement to raise a house and build under it another story, the building, while the work was progressing, fell and injured the adjoining property. The owner of the adjoining house entered suit for damages against the owner of the house undergoing alterations, but was defeated. The court held that the contractor was alone responsible, and said: "The distinction on which all such cases turn is this: If the person employed to do the work carries on an independent employment, and acts in pursuance of a contract with his employer, by which he has agreed to do the work on certain specified terms, in a particular manner, and for a specified price, then the employer is not liable. The power

of directing and controlling the work is parted with by the employer, and is given to the contractor." There are exceptions to this rule, however, where the courts have placed the blame upon the owner; such a case was decided by the Supreme Court of Massachusetts. It seems in this particular case a mason contracted to build a party wall. At the time the work was done there was freezing weather, and when the wall had progressed as high as the fourth story, and the floorbeams were in place, the weather moderated, causing the mortar to thaw. The wall, thus softened, fell and damaged an adjacent building. In the suit which followed, the owner of the wall claimed that the contractors were alone responsible. Evidence was introduced tending to prove that the wall had not been properly braced, though it had been accepted by the architect as far as it had progressed; and also that the strength of the wall had been impaired by flues, built in it, at the request of the owner of the adjoining property. The court, however, refuted the claim of the owner, that the contractor was alone responsible, by saying: "The general rule of law is that the person who, for his own purposes, brings on his land, and collects and keeps there, anything likely to do mischief if it escapes, must keep it at his peril; and if he does not do so is, *prima facie*,* answerable for all the damage which is the natural consequence of its escape. This rule has been applied to dangerous animals, cesspools, to reservoirs, and to accumulations of snow and ice upon a building, by reason of the form of its roof."

It has generally been held in court, that where the fault or injury was due to the negligence of a subcontractor, the principal contractor was responsible.

If the contract provided that the building is to be erected according to certain plans and specifications, and the contractor agrees to such a stipulation, with the result that,

*In law, a prima facie case is one which is established by sufficient evidence, and can be overthrown only by rebutting evidence adduced by the other side—a case consisting of evidence sufficient to go to the jury; that is to say, one which raises a presumption of fact, and hence will justify a verdict, though it may not require one.

when erected, the building is faulty and unsafe, it has been settled in the courts that the contractor cannot be held responsible if he has fulfilled the contract, and carefully carried out the drawings and specifications. On the other hand, should he change the construction, or deviate from the drawings or specifications, he is held responsible for the safety of the building.

65. Insurance.—The average contractor is called upon to run numerous risks from fire, etc., which, if realized, would more than likely bankrupt him beyond any possibility of recovery. If the building should burn down, or be subjected to destruction by any other unforeseen agency, during the progress of construction, it is generally held that the contractor is responsible, and is bound by the stipulations in the contract; though sometimes it is provided in the contract that should the contractor be delayed by such agencies as fire, water, cyclones, etc., an extension of time will be granted.

Hence it is the duty of the builder, both towards himself and the owner, to guard against such contingencies by taking out the proper insurance on the building. The law is quite strict with contractors who have been unfortunate enough to have the building destroyed for which they contracted, and usually holds that he must finish the building according to the terms of the contract, no matter how severe it may be upon him. It has sometimes been held, when a building has been destroyed by some unforeseen agency, that the builder was released from his contract by the "act of God," that is, by some power beyond human control. Such a case occurred in Connecticut, where a contractor had agreed to build a schoolhouse; it was nearly completed and $1,000 had been paid on account when it was struck by lightning and burned. The committee with which the contract had been made asked the contractor to commence rebuilding, and offered to extend the time of completing, which was nearly up when the fire occurred. The contractor, however, refused, saying that he had been released from the contract

by an "act of God." The decision of the Supreme Court was against this, however, and held that he was not released.

66. Responsibility for Accidents.—The following rule of the Supreme Court of Illinois in a similar case, where the building under erection was blown down once and fell down the second time, caused, according to the contractors, by unforeseen defects in the soil, is interesting and explains itself: "If a party enters into an absolute contract, without any qualifications or exceptions, and receives from the party with whom he contracts the consideration of such an engagement, he must abide by the contract, and either do the act, or pay the damages; his liability arises from his own direct and positive undertaking." "If the covenant be within the range of possibility, however absurd or improbable the idea of execution may be, it will be upheld; as where one covenants it shall rain tomorrow." "To bring the case within the rule of dispensation, it must appear that the thing to be done cannot by any means be accomplished; for, if it be only improbable, or out of the power of the obligor, it is not deemed in law impossible." "No matter how harsh and apparently unjust in its operation the rule may occasionally be, it cannot be denied that it has its foundation in good sense and inflexible honesty. He who agrees to do an act should do it unless absolutely impossible. He should provide against contingencies in his contract. Where one of two innocent persons must sustain a loss, the law casts it upon him who has agreed to sustain it, or rather, the law leaves it where the agreement of the parties has put it." The court further said, in reciting the case, "If a party for a sufficient consideration agrees to erect and complete a building on a particular spot, and to find all the materials and do all the labor, he must erect and complete it, because he has agreed to do so. No matter what the expense, he must provide such a substructure as will sustain the building upon the spot, until it is completed, and delivered to the owner." "If the difficulties are apparent on the surface, he must overcome them. If they are not, but become apparent by excavation,

or the shrinking of the building, the rule is the same." "The cases make no distinction between accidents that could be foreseen when the contract was entered into, and those that could not have been foreseen; between accident by the fault of the contractor, and those where he is without fault; they all rest upon the simple principle. Such is the agreement, clear and unqualified, and it must be performed, no matter what the cost, if performance be not absolutely impossible." "The whole defense was properly overruled, because it did not show the performance of the contract impossible, or any lawful excuse for non-performance of the contract."

ARCHITECT'S AND OWNER'S RESPONSIBILITY.

67. Suits for Liability.—In The American Institute of Architects' and the National Association of Builders' official form of contract, given in full in Art. **76,** it will be noticed that there is in Article I a stipulation that the architect is "acting, for the purpose of this contract, as agent of said owner." In case of suit for liability which might be entered against the owner, by persons injured while working on the building, this clause is likely (and especially so under the laws of some states) to cause trouble; for a shrewd lawyer might trace every occurrence about a building as emanating directly through the orders of the architect, who, acting as agent, makes the owner responsible for such occurrences; and hence the particular one that led to the injury of the plaintiff.

Such a calamity may be guarded against by some such clause as is given in the first form of contract hereinafter referred to. This clause places the responsibility for liabilities upon the contractor, and reads as follows: "The contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damages, and all injury of the same, before the completion of this contract, shall be made good by him; and shall be solely

answerable for all damage or delay to the owner or his property, to other contractors or other employes of the owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work covered by this contract or any extra work undertaken as hereinafter provided."

The architect is thus relieved of his position as agent in all cases that might place the responsibility for liabilities upon his client, by that portion of the clause in the same contract which reads: "Neither the architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the contractor; and further, the architect shall not be deemed the agent of the owner for any purpose whatsoever, except as the owner may in fact give him a special and express authority."

Since most first-class builders have their liabilities insured, they would have no incentive to throw such responsibilities upon the owner; but in order that the owner may be secure against any legal action by injured employes, it would be best to insert such clauses as are given above.

68. Importance of Insuring.—Where the rules of the insurance companies will allow it, the owner should insure his own and also the risks of all the contractors engaged upon the work, which, in case of loss by fire, will be paid according to the particular interests of the parties engaged. Should the laws of the insurance companies not permit them to issue a policy in the names of more than one person, the builder should be required to insure to the full amount of his interest; and, since they are apt to neglect doing so for the sake of the financial saving, the architect should demand this policy and see that it is all that is required, retaining it in his hands for safe keeping.

The importance of a stipulation to this effect is evident; for if the builder should neglect to insure, and the partially erected building should burn down, he would, in many cases, be thrown into bankruptcy and the owner would be compelled to finish the contract with the assignee or some other contractor.

LEGAL MEANING OF WORDS.

69. "Commencement" and "Erection."—A question sometimes arises as to when a building is properly *commenced;* whether it is when the batter boards are set, when the excavation is started, or when the first footing stone is laid. The New Jersey Supreme Court held the opinion in two cases that a building was commenced when the excavation was begun.

The direct meaning of the word *erection* is somewhat obscure, and, while it is a word much used in contracts and specifications, there seems to be a great difference of opinion in regard to what may be inferred by the phrase *upon the erection of.* Some hold that it means the completion of the building or structure; others claim that something else is meant. A case in Illinois called for a decision from the Supreme Court as to when a building should be considered as being erected. The court decided that the building in question be considered as erected, although it had no roof on, and not one gable or chimney was built; the flooring had not been laid, but the materials for the roof, floor, and windows had been delivered on the ground. In Indiana, it was held by the court that a house had been erected wherein the plastering had not yet been done, and some of the windows had not been placed; and most of the states in which such cases have arisen have held the opinion that a building was erected where the walls were up and materials on the site with which to complete it.

70. "As Directed."—The expression *as directed*, as pertaining to its use in specifications in connection with the manner in which work shall be done, was passed upon by the

Supreme Court of Missouri, during a controversy as to whose directions were meant, and was held to imply those of the owner.

71. "Not Less."—The phrase *not less*, which is much used in specifications, hence forming a term in the agreement, seems to be rather unnecessary in most cases, and liable to cause trouble. It is principally used in making some such stipulation as this: "The cellar shall be excavated to a depth of not less than ten feet." A stipulation like this was made in a contract for the erection of a building in the state of New York. After the contractor had excavated to the required depth, it was found that the nature of the soil required further excavation in the footing trenches, and in consequence the cellar wall had to be extended. In the suit brought by the contractor to recover the cost of the extra work, it was decided by the Supreme Court that it was due him. In all cases of this kind, the court will carefully consider the meaning of the contract to determine whether the contractor really intended to bind himself to do the work beyond the given dimensions should the architect, in the execution of the work, deem it advisable, owing to the conditions unforeseen.

72. "More or Less."—A contract will sometimes stipulate that a certain amount of material *more or less* shall be furnished. A New York court held that the term as used implied the delivery and acceptance of just the actual amount of material required for the work, and that the term as used did not mean any definite quantity.

73. Other Phrases.—In most formal contracts, it is usual to refer to the specifications, which constitute part of the agreement, as the *specifications hereto annexed.* It is held by the courts that it is not necessary that the specifications should be actually attached to the formal contract; for so long as the particular specification referred to in the contract can be proved as the one meant, it is all that is legally required. Also, if the phrase, *the specifications signed herewith*, is used in the formal contract, it is not actually required that they should be signed, provided the ones

intended in the formal contract can be identified without such signatures. It undoubtedly would be advisable, however, to have all specifications, and even plans, signed, so that there may be no controversy in regard to the ones designated in the formal contract.

FORMS OF CONTRACT.

74. Specimen Contracts.—The preceding pages have been devoted to points of law likely to be raised in respect to contracts, the study of which will enable the student, when he is called upon to become a party to a contract, to do so intelligently.

The two forms of contract which are now given in full are representative and legally correct. The first form is very complete, provisions being made in it to cover every contingency that is likely to arise in an important building operation, and which long experience in building transactions has demonstrated should be guarded against. The second form is more brief, and not so complete in the extent of the ground covered, but is the one that is generally used. This contract is the official contract of The American Institute of Architects and National Association of Builders, and, being copyrighted, can only be used in the printed form, which is obtainable at nearly all stationery supply stores. It has been carefully compiled by a joint committee of the Institute and Association, and is subject to such change and modification each year as may be deemed necessary to make it more complete or binding.

75. Building Contract.—The text of the ordinary building contract herein first referred to follows:

BUILDING CONTRACT

between..... .....of.....
hereinafter called the Owner, and.....
of.....hereinafter called the Contractor, made
at.....the.....day of.....18, ...

The respective parties hereto, each in consideration of the agreements of the other herein set forth, agree each with the other as follows:

THE CONTRACTOR'S AGREEMENT.

The Contractor agrees to.....

.....

according to certain plans and specifications prepared by.....

.....of.....Architect. Said plans and specifications, together with this contract, of which they are to be deemed a part, are to be construed together, so that any work shown on the plans, though not mentioned in the specifications, or vice versa, or any provision of the contract not repeated in the plans or specifications, or vice versa, is to be executed by the Contractor as a part of this contract. Figured dimensions are to prevail over scale measurements. All things which in the opinion of the Architect may fairly be inferred from the plans and specifications, are to be executed by the Contractor as a part of this contract. If complete drawings of details have not yet been made, the same, when made and conforming to said plans and specifications, are to constitute a part of this contract, the Architect being the sole judge as to whether said detailed drawings conform to said plans and specifications. All the plans and drawings received by the Contractor at any time during the continuance of this contract are at its termination to be returned to the Architect.

All material and work, where the quantity, dimensions, and quality are not shown on the plans or specified in the specifications, are to be furnished in sufficient quantity and of sufficient dimensions for the proper execution of the work as determined by the Architect, and the quality and workmanship are to be the best throughout and satisfactory to the Architect.

The Contractor is to take out at his own expense all necessary permits from the municipal or other public authorities, to give all the notices required by law or municipal ordinance, and to pay all fees and charges incident to the due and lawful prosecution of the work covered by this contract.

If this contract involves excavation or masonwork, the Contractor is to execute the same without encroaching upon adjoining public or private property, and shall procure for the Owner the certificate of some competent surveyor, to be selected by the Owner, that there has been no such encroachment; unless the plans themselves provide for such encroachment, in which case the Contractor shall be relieved from all responsibility as to the correct location of the walls and foundations in this respect.

The Contractor shall devote his time and personal superintendence to the execution of this contract, and shall employ a competent foreman or clerk of the works, who shall at all times be present while any work is being done under this contract, at the building.

The entire work and all its parts, including material, workmanship,

and rate of progress, shall be satisfactory to the Architect. All materials rejected by the Architect, whether worked or unworked, and whether affixed to the building or not, shall be removed from the premises (and for that purpose taken down if already attached to the building) at the request of the Architect; and all work condemned by the Architect, as in any way unsound or as not conforming to the terms of this contract, shall be taken down forthwith and rebuilt by the Contractor in accordance with the contract and in a manner satisfactory to the Architect. The Contractor shall dismiss any of his employes if the Architect considers said employes incompetent or careless and so informs the Contractor.

The Contractor shall clear away all dirt and rubbish caused by his operations as often as requested by the Architect or Owner, and shall leave the premises at the termination of this contract free from such dirt and rubbish and in a neat and clean condition.

The Contractor shall prosecute the work speedily and continously

.....

.....

and the entire work covered by this contract shall be finished by the .....day of.....18.... The damages for default are fixed at.....dollars for every day thereafter that the said work shall remain unfinished.

The Contractor shall make good all defects, omissions, and violations of the terms of this contract whensoever discovered, during the progress of the work or afterwards, notwithstanding any payments that may have been made, or any certificates that may have been given, or any possession or acceptance of the work by the Owner, and shall be responsible for any damages that may be caused in making good said defects, omissions, or violations.

The Contractor shall comply with all the laws, ordinances, and regulations for the time being in force in the city or town where the building is situated and relating to the building or other work included in this contract, and shall satisfy all the requirements of the Inspectors (if there be such).

The Contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damage, and all injury to the same, before the completion of this contract, shall be made good by him; and shall be solely answerable for all damage or delay to the Owner or his property, to other Contractors or employes of the Owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the Contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work

covered by this contract or any extra work undertaken as hereinafter provided.

The Contractor shall have sole charge and possession of the work covered by this contract until the termination thereof; but shall permit the Owner and the Architect and any person employed by either of them to visit, enter, and inspect the said work at all times and places during the progress thereof, and shall provide safe and proper facilities for such inspection.

The Contractor shall permit other contractors or employes of the Owner to prosecute their work, and shall render them all necessary assistance.

THE OWNER'S AGREEMENT.

The Owner agrees to pay the Contractor the sum of..... dollars according to the following schedules and subject to the conditions hereinafter set forth:

The first payment to be .....dollars ($.....)

.....

The second payment to be .....dollars ($.....)

.....

The third payment to be .....dollars ($.....)

.....

The fourth payment to be.....dollars ($.....)

.....

The fifth payment to be.....dollars ($.....)

.....

The sixth payment to be .....dollars ($.....)

.....

The seventh payment to be.....dollars ($.....)

.....

.....

.....

and the balance.....dollars ($.....)

thirty-five days after the completion of this contract.

Total..... $.....

Provided, however, that none of the foregoing payments shall be due or payable, unless the following conditions shall have been complied with:

1. Unless the work to the stage in question has been done in the manner herein agreed, and there has been no breach by the Contractor of any of the provisions of this contract.

2. Unless the Contractor shall deliver to the Owner the written certificate of the Architect that the work to the stage in question has, in his opinion, been done in the manner herein agreed.

3. Unless (if the contract includes excavations or masonwork on outside wall) the Contractor shall deliver to the Owner the written certificate of some competent surveyor to be selected by the Owner that there has been no encroachment upon adjoining public or private property.

4. Unless the property is free from all lien for debts due or claimed to be due from the Contractor, and satisfactory evidence thereof furnished (if requested) to the Owner.

ALTERATIONS AND EXTRAS.

The Architect may, in writing, and from time to time, order the Contractor to make any changes in the work which do not increase the cost to the Owner or affect the time of completion. In case said changes make the work less expensive to the Contractor, a proportional deduction shall be made from the contract price above specified. In no case shall any change be made in the work which shall increase the cost of the work to the Owner, or involve any extension of time, without his express and special consent; and, if the Contractor shall proceed to execute such change without first obtaining such consent, he shall be concluded against making any extra charge for the said change or any claim for further time.

In case of any change ordered by the Architect as aforesaid, or in case any other changes in the work are made by the mutual consent of the parties hereto, whether affecting the contract price or not, or the time of completion or not, all and singular the other provisions of this contract shall remain in force, and apply to the contract as thus altered.

ORDERS.

If any orders are accepted by the Owner (and it is understood that he shall be under no obligation to accept any), such acceptances shall be conditional on the due performance by the Contractor of all and singular the provisions of this contract, and subject to alterations as aforesaid.

THE ARCHITECT.

The Architect mentioned in this contract is understood to be .....of.....or such other Architect as the Owner may hereafter select; any change to be notified to the Contractor in writing.

The Architect shall have authority to enter and inspect the work at all times, to reject all material (whether set up or not) and to condemn

all work which in his opinion is not in conformity with the provisions of this contract, and to do all the things hereinbefore set forth as within his powers. Neither the Architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the Contractor; and neither of them shall have power to order extras or alterations, except as above provided, or any authority other than that expressly set forth in this contract. The Architect shall not be deemed the agent of the Owner for any purpose whatsoever, except as the Owner may in fact give him a special and express authority.

MISCELLANEOUS PROVISIONS.

No payment of money under this contract, nor any acceptance or possession taken of the work done by the Contractor, nor any certificate given, shall be evidence of the performance of this contract or be construed as a waiver of any of its provisions by the Owner; nor shall any waiver of any breach of this contract be held to be a waiver of any other or subsequent breach.

If, in the opinion of the Architect, the Contractor is obstructed or delayed in the prosecution or completion of the work by the neglect, delay, or default of any other contractor, or by any damage which may happen thereto by fire, or by the unusual action of the elements, or by the abandonment of the work by the employes in a general strike, then the Contractor shall be entitled to such extension of the time specified above for the completion of the work as the Architect shall in writing certify; provided, however, that claim is made by the Contractor at the time and in writing.

If at any time before the completion of this contract the Contractor becomes bankrupt or insolvent, or makes an assignment for the benefit of creditors, or assigns this contract or sublets any part of it without the consent of the Owner first obtained in writing, or becomes incapable of completing the contract, or shall at any time for six days refuse or neglect to proceed with the contract work in the manner herein agreed to the satisfaction of the Architect, then the Owner may at once terminate this contract by a written notice delivered to the Contractor in person or at his usual place of business, and proceed to complete the work with other mechanics or contractors, and account to the Contractor or his legal representatives as follows: The Owner shall be credited with all payments theretofore made by him to the Contractor, with the entire cost of completing the work with said other mechanics and contractors, and with all damages by delay or otherwise, caused by the default of the Contractor, including reasonable expenses of counsel. If the contract price exceeds the total amount of

these credits, the excess shall be paid to the Contractor or his legal representatives. In case orders accepted by the Owner are outstanding, the holders thereof shall be entitled to such excess in preference to the Contractor or his legal representatives. If, however, the total amount of the said credits exceeds the contract price, the excess shall be due from the Contractor to the Owner. In such accounting, the Owner shall not be held to obtain the lowest figure for the work of completing the contract; but all sums actually paid by him for such completion shall be credited to him.

All material delivered at the building by or on account of the Contractor, and intended to be incorporated with the building, shall become the property of the Owner as delivered; but the Contractor may repossess himself of any surplus left at the completion of the contract. All scaffolding, apparatus, ways, works, machinery, and plant brought upon the premises by the Contractor, or used by him, shall remain his property, but in case of default and a completion of the contract work by the Owner, the latter shall be entitled to use the said scaffolding, apparatus, ways, works, machinery, and plant without cost or liability for depreciation or injury by use.

If the Owner does not make the payments herein provided as and when the same shall become due and payable he shall be liable to the Contractor for interest on the same; and if such default continues for a period of ten days, the Contractor may, by a written notice delivered to the Owner in person or at his usual place of business, terminate this contract. But the acceptance of any money under this contract subsequent to such defaults shall operate as a waiver thereof and of the right to terminate this contract by reason thereof.

The Owner shall keep the building and the material on the premises insured against fire in such companies as he shall select, for the benefit of himself or any mortgagee and of any and all contractors on the building who shall request such insurance in writing. The expense of said insurance shall be borne by the Owner; but he shall not be responsible for carrying too little insurance, unless the Contractor has requested him in writing to insure in a certain specified amount, and the Owner has neglected to do so for an unreasonable length of time. In the event of a fire, the insurance shall be divided between the Owner and any mortgagee and those contractors for whose benefit the insurance was taken out, as their interests may appear; and the parties hereto shall respectively proceed to the completion of this contract.

All disputes arising out of this contract or the performance or breach thereof shall be settled by mutual agreement or in a court of law or equity before a single justice, auditor, or special master, and no claim shall be made for a trial by jury on the whole case or special issues.

In witness whereof, we, the said .....
and the said.....
hereto set our hands and seals this.....day of .....18....

76. "Uniform Contract."—The so called "Uniform Contract" adopted by The American Institute of Architects and the National Association of Builders is a printed instrument with spaces left for filling in the specific details peculiar to each case, as shown in Form I. The six lines left blank for the names of the contractor and owner, are ample for the name and address of either party when it consists of a firm or long-titled corporation. The fourteen lines at the bottom of Form I are for a complete description of the building to be erected, together with its location.

Form II is printed on the second page of the "Uniform Contract" and continues the terms of the agreement down Art. VI, where five lines are left for the dates at which various portions of the building shall be completed; and six additional lines are left blank to insert provisions for contingencies of delay, such as strikes, interference of other contractor, severe weather, etc.

Form III constitutes the third page of the "Uniform Contract" and contains in Art. IX space for the gross amount of the contract to be written in; under which are provided blank lines whereon to state the number, amount, and time of payment of each instalment of the contract price.

Art. XI provides the insurance clause and leaves spaces for special conditions of insurance, if such are required. Then follows the space for the signatures of the contracting parties, while under the words "In presence of" is placed the signature of a witness, who is usually, though not necessarily, the architect.

The contract is folded twice, after it has been signed, and on the outside of the fourth page is a blank form, which, when filled out, gives information regarding the document, as shown in Form IV. This is not necessarily a part of the document, but it is simply an indorsement or index by which the contract may be recognized without unfolding it.

PERMITS.

INTRODUCTION.

77. Granting of Permits.—After the plans and specifications have been prepared and the contract has been drawn up and signed, and before the actual work can be commenced, it is necessary for the contractor to comply with the ordinances of the city in regard to the securing of the proper permits. The laws and ordinances governing the granting of permits vary somewhat throughout the country; hence it will only be possible to consider the permits granted by some representative city.

New York being the largest building center in the United States, and the city from which many smaller cities and towns have modeled their building laws and ordinances, the permits there required will be taken as a model and considered in detail.

78. New York Practice.—The building laws of New York City require that: "Before the erection, construction, or alteration of any building, or part of any building, or any platform, staging, or flooring to be used for standing or seating purposes, in the City of New York, is commenced, the owner or his agent or architect, shall *submit* to the superintendent of buildings a detailed statement in writing of the specifications, and a full and complete copy of the plans of such proposed work, which shall be accompanied with a statement in writing, sworn to before a notary public or commissioner of deeds, giving the full name and residence (street and number) of the owner, or of each of the owners of said building, or proposed building, platform, staging, or flooring. If such erection, construction, or alteration is proposed to be made by any other person than the owner or owners of the land in fee, the person or persons intending to make such erection or alteration shall accompany said detailed statement of the specifications and copy of the

plans, with a statement in writing, sworn to as aforesaid, giving the full name and residence (street and number) of the owner or owners of the land and also of every person interested in said building or proposed building, platform, staging, or flooring, either as owners, lessee, or in any representative capacity. Such statement may be made by the agent or architect of the person or persons hereinbefore required to make the same. Said sworn statement, and detailed statement, and copy of the plans, shall be kept on file in the office of the superintendent of buildings, and the *erection, construction, or alteration of said building, platform, staging, or flooring, or any part thereof, shall not be commenced or proceeded with, until said statements and plans shall have been so filed, and approved by the superintendent of buildings.*"

APPLICATION FOR PERMIT FORMS.

79. The Statement or Affidavit.—The sworn statement required by the above building ordinance is obtained in a printed form from the department of buildings of the City of New York. These forms may be obtained either for the "Erection of New Buildings," as shown in Form V, or "Alterations to Existing Buildings," as shown in Form VI.

The architect fills out either of these statements, according to whether it is the construction of a new building, or alteration, for which the permit is desired. This statement must be sworn to by the owner, before any duly authorized notary public or magistrate. But in regard to the securing of permits, the building laws of New York City state: "But the superintendent may, in his discretion, and for reasons to be stated in writing by the applicant, and filed with the plans and detailed statements, dispense with the making of said sworn statement in any case. Nothing in this action shall be construed to prevent the superintendent of buildings from granting *his approval for the erection of any part of a building*, where plans and detailed statements have been presented for the same,

before the entire plans and detailed statements of said building have been submitted. Any false swearing in a material point in any statement submitted in pursuance of the provisions of this section shall be deemed perjury, and shall be punished as such. *Ordinary* repairs may be made without notice to the department of buildings, but such repairs shall not be construed to include the cutting away of any stone or brick wall, or any portion thereof, the removal or cutting of any beams or supports or the removal, change, or closing of any staircase."

The specifications mentioned in the preceding ordinance are in the form of blank applications, which should be filled out by the architect. These printed application blanks may be obtained from the department of buildings, and are in two different forms; one for the erection of new buildings, and the other for alterations to existing buildings, whichever may be required.

80. The Application.—The "Application for Erection of New Buildings," the first page of which is shown in Form VII, is filled out by the architect and submitted to the department of buildings, with the plans of the proposed structure and the affidavit of the owner.

The second page of the application, shown in Form VIII, calls for additional information concerning the occupancy of the building and the use of party walls. On this page is also printed an extract from the building laws regarding bond stones, fire-escapes, etc., so that there may be no excuse for not carrying the work out in accordance with the regulations.

The third page of the application, shown in Form IX, is reserved for the building inspector's report, wherein he calls to the attention of the department any violations of the laws or regulations committed during the erection of the building.

The fourth page of the application, shown in Form X, is reserved for the indorsement or title, together with a blank form on which the superintendent of buildings signifies his

approval or disapproval of the application and states his reasons therefor.

If *disapproved*, the application and plans must be altered so as to conform to the requirements of the department, before the permit to build will be granted. When all the requirements have been fulfilled and the application is signed by the superintendent, it becomes a *permit*, and a copy of it is given to the architect (or the builder) to show, in case his authority to build is questioned.

81. Permit for Alterations.—When the permit required is for an alteration to an existing building, then the first page of the application is as shown in Form XI, and the second page as in Form XII. The information demanded in this application pertains almost entirely to the character and condition of the existing building, as no matter how well a building may be constructed, the law requires that any alteration in it must comply with all the latest regulations of the building department. A building erected twenty years back as a private residence may be altered at present to be used as a factory. Then every regulation, regarding fire-escapes, ventilation, plumbing, etc., must apply to this structure as a factory, and its existence as a residence ceases when the alteration in *purpose* is made, whether any material alteration to the building has been made or not. The third and fourth pages of the "Application to Alter, Repair," etc. are similar to Forms IX and X.

82. Plumbing Permits. — The permit required for alteration or erection of plumbing work, is in the form of a specification of the materials and fixtures to be used. This specification is obtainable in blank from the building department, as shown in Forms XIII to XVII. It contains eight pages, three of which are omitted herein. These three pages follow between Forms XV and XVI, and contain the fourteen articles of regulations governing the plumbing, drainage, water supply, and ventilation of New York buildings.

When the plumbing specifications are signed by the commissioner of buildings they constitute both a permit and a specification by which the work must be done.

83. Light and Ventilation Permits.—If the building to be erected has the character of a hotel; apartment house, tenement or lodging house; office building; theater; or, in fact, any building wherein there is likely to be assembled a large number of people, either for living, business, assembly, or amusement, there will be required from the architect a filled-out application for the approval of the plans for light and ventilation of the proposed tenement or lodging house, etc. This application, which is obtainable in a printed form from the department of buildings, is shown in Forms XVIII to XXIII.

84. Other Permits.—Before the actual building operation can be carried on, it is necessary that permits shall be obtained for the obstruction of the street and sidewalk, due to the process of excavation, and to materials lying thereupon. Permits must also be obtained for opening the street, and tapping the water main in order to get a supply for building purposes; and also to make connections for the service pipe, and connections for the drainage to the sewer. These permits are usually obtained by the contractor, as stipulated in the general conditions of the specifications. The other permits for opening the streets, to tap gas and steam mains, and to make electrical connections, are usually taken care of by the gas, steam, and electrical companies who are going to supply the gas, steam, or electricity.

85. Plans and Affidavits.—It will be necessary for the architect, after he has drawn up these application forms, to send with each a complete set of plans, setting forth all the information that will be required by the particular application blank.

For instance, with the "Application for Erection of Buildings," there should be sent a complete set of plans, together with a survey of the ground plot showing the

buildings located upon it. The plans should set forth the dimensions of the building, show the size of foundation and foundation piers, window and door openings, thickness of walls, design of floor system, beams and girders, etc., supporting piers, columns, roof construction, and, in fact, all necessary information in regard to the general plans and construction of the building. All plans must be drawn to a uniform scale and must be on tracing cloth, or cloth prints, properly designated and colored. The plans, which accompany the specifications for the plumbing and drainage, should be made in ink upon tracing cloth, or cloth prints should be provided, and should show in full particulars all the sanitary arrangement of the building with all supply, sewer, and vent pipes, together with all particulars in regard to how they are connected and run, also all partitions and method of ventilating water-closet apartments, and in what portion of the building these are located.

In order to clearly show all that is required, it will generally be necessary to furnish plans, a longitudinal and transverse cross-section, and detail sections where required.

The application to the superintendent of buildings, to approve plans for light and ventilation, should be accompanied by drawings which should include the plans for all floors, including the cellar and basement, and, if necessary, transverse and longitudinal sections of the building; each shaft and court should be shown and the dimensions of the same clearly marked. All plans must be drawn to a uniform scale, not less than one-quarter inch to the foot, and be tracings on cloth or cloth prints.

Where the plans prepared to accompany the general "Application for Erection of Buildings" clearly show all that is required under the application for light and ventilation, it is seldom necessary to prepare additional plans as above mentioned, as the one set will answer both purposes, though it is sometimes advisable to prepare the additional plans where there is likely to be complication and confusion in the attempt to show the features of both applications on the one set of drawings. Other particulars in regard to

making drawings, to accompany the application, which shall fulfil the requirements of the building department, are stipulated on the printed forms, and must be complied with.

It is necessary, therefore, before a building permit can be secured for the architect, to prepare a sworn statement or affidavit. He will also be required to fill out and prepare triplicate copies of the application for "Erection of Buildings" together with triplicate copies of the "Specifications for the Plumbing and Drainage," and where the building is a lodging, tenement, apartment house, or some similar structure, triplicate copies will be required of the application for the approval of plans for light and ventilation. Of these triplicate copies, *one*, signed by the superintendent of buildings, called the *original*, is kept on file in the building department; the other two are considered copies and are given, one to the architect as his permit, and the other to the building inspector, in order that he may see that the terms are properly complied with.

With the sworn statement and the triplicate copies of each of the applications there should be furnished the requisite plans pertaining thereto; only one set of plans being required to accompany the three copies of each of the application blanks.

One plan or survey of the lot or plot of ground, with the plan of the building outlined upon it, shall also be furnished and sent with the applications and sworn statement. It is required that the building lines be shown upon the ground plan sent with the general "Application for Erection of Buildings."

GRANTING OF PERMIT.

86. Department of Buildings.—After the affidavit, application, and plans have been filed, the department of buildings will, in due course of business, consider them. If they are approved the architect will be notified to that effect, and upon applying at the department will receive one of each of the applications. These applications will be marked

approved and signed by the commissioner or his deputy, and thus signed will constitute the permits.

Should the plans and applications be disapproved, the architect will be so notified. Upon applying at the department, the plans and specifications will be handed to him, the particular items or details that have been disapproved will be marked on the applications and upon the drawings, and the applications will be marked disapproved upon the back. The architect after noting the items that have been disapproved should, upon an amendment blank furnished by the department, correct each item, successively, in such a manner as he may think will meet the approval of the department; and he may, if it will not confuse the drawings materially, correct such details upon them as have been disapproved. All the above must be attended to at the department, as they will not permit the plans and applications to be taken away: though the architect may, if the changes in the original drawings are considerable, make new drawings at his office that will embody the changes required by the department, and file them with the amendment.

When the amendment blank has been finished by the architect, and the changes have been made upon the drawings, they will be returned to the clerk, who will stamp the amendment with the date, and the application will be again considered. If the amendment is approved, the architect will be notified, and upon applying at the department he will copy the items of the amendment upon the back of the application blanks and sign his name. The applications will then be signed by the commissioner or his deputy, and will constitute the permits.

Sometimes the department will approve the application for "Erection of Buildings," when the application for "Plumbing and Drainage," or "Light and Ventilation" may still be held by the department under advisement; in such a case, the architect may make arrangements with the contractor to proceed with the work. This, however, is not always advisable, for should the application for "Plumbing and Drainage" or "Light and Ventilation" be afterwards

disapproved, and require amending before they are granted by the department, it may materially affect the work already started and cause considerable trouble and expense. Therefore, whenever possible, it would be well to obtain all of the required permits before commencing the work on the building. The excavation may be commenced, however, and in most cases the foundations laid without great risk of having such work affected by the subsequent "Plumbing and Drainage" or "Light and Ventilation" permits.

NEW YORK BUILDING LAW.

POWERS OF SUPERINTENDENT OF BUILDINGS.

87. The Superintendent of Buildings.—In connection with the application for permits, it will be interesting to note the powers of the superintendent of buildings, and the provisions made by which the building laws may be modified, also the penalty for violating the same. Therefore, the following is quoted from the building laws of New York City.

"The superintendent of buildings shall have power (except as herein otherwise provided) to pass upon any question relative to the *mode*, *manner of construction*, *or materials* to be used in the erection or alteration of any building, or other structure, provided for in this title, in any part of the city of New York, to make the same conform to the true intent and meaning of the several provisions of this title.

"He shall also have the power to vary, or modify, the provisions of this title, upon application to him therefor, in writing, by an owner of such building or structure, or his representative, where there are practical difficulties in the way of carrying out the strict letter of this law, so that the spirit of the law shall be observed, the public safety secured, and substantial justice done.

"But *no such deviation* shall be permitted, unless a record of the same shall be kept by the said superintendent of buildings, and a certificate to be first issued to the party applying for the same."

BOARD OF EXAMINERS.

88. Certificate of Board of Examiners.—"Certificate shall not be issued by the superintendent until a board of examiners, consisting of a member of the 'New York Chapter of the American Institute of Architects'; one member of the 'New York Board of Fire Underwriters;' two members of the 'Mechanics and Traders' Exchange' of said city, one of whom shall be a master mason and one a master carpenter; one member of the 'Society of Architectural Iron Manufacturers' of said city; one member of the 'Real Estate Owners' and Builders' Association' of said city, who shall be an architect or builder; one member of the 'New York Real Estate Exchange, Limited,' who shall be an architect or builder; and the chief of said fire department; all of whom shall be appointed by their respective organizations (and so certified to annually to said superintendent of buildings), shall also approve the proposed modifications of the law. The said examiners shall each take the usual oath of office before entering upon the performance of their duties. The superintendent of buildings shall be, ex officio, a member of said board of examiners, and be chairman thereof.

"In cases in which it is claimed by an owner, in person, or by his representative, that the provisions of this title do not directly apply, or that an equally good and more desirable form of construction can be employed in any specific case than that required by this title, then such person shall have the right to present a petition to the board of examiners, through the superintendent of buildings, and may appear before said board and be heard; and said board shall consider such petition in its regular order of business, and, as soon as practicable, render a decision thereon.

"The said board of examiners are hereby authorized and empowered to grant or reject such petition, and their decision shall be final. If such decision is favorable to said petitioner, a certificate shall be issued by the superintendent of buildings in accordance therewith. At least five affirmative votes shall be necessary to the granting of any application or

petition by said board. No member of said board shall pass upon any question in which he is pecuniarily interested. The said board shall meet once in each week or upon notice from the superintendent of buildings.

"The chief clerk in the office of the superintendent of buildings shall be the clerk of the said board, and shall keep a record of its proceedings, which shall be kept in the office of the superintendent of buildings."

VIOLATIONS AND PENALTIES.

89. Penalties.—"The owner or owners of any building, or part thereof, upon which any violation of this title may be placed, or shall exist, and any architect, builder, carpenter, or mason, who may be employed or assist in the commission of any such violation, and any and all persons who shall violate any of the provisions of this title, or fail to comply therewith, or any requirement thereof, or who shall violate, or fail to comply with, any order or regulation made thereunder, or who shall build in violation of any detailed statement of specifications or plans, submitted and approved thereunder, or of any certificate of permit issued thereunder, shall severally, for each and every such violation, and noncompliance, respectively forfeit and pay a penalty in the sum of fifty dollars, except that any such person who shall violate any of the provisions of this title as to the construction of chimneys, fireplaces, flues, hot-air pipes, and furnaces, or who shall violate any of the provisions of this title, with reference to the framing or trimming of timbers, girders, beams, or other woodwork in proximity to chimney flues or fireplaces, shall forfeit and pay a penalty in the sum of one hundred dollars.

"But if any said violation shall be removed or be in process of removal within ten days after the service of a notice as hereinafter prescribed, the liability for such penalty shall cease, and said department shall discontinue any action pending to recover the same, upon such removal or the completion thereof within a reasonable time."

90. Failure to Comply With Notice.—"Any and all of the afore mentioned persons, who, having been served with a notice as hereinafter prescribed, to remove any violation, or comply with any requirements of this title, or with any order or regulation made thereunder, shall fail to comply with said notice within ten days after such service or shall continue to violate any requirement of this title in the respect named in said notice, shall pay a penalty of two hundred and fifty dollars.

"For the recovery of any said penalty or penalties an action may be brought in any district court, or court of record, in said city, in the name of the department of buildings; and whenever any judgment shall be rendered therefor, the same shall be collected and enforced, as prescribed and directed by the Code of Civil Procedure of the State of New York.

"The department of buildings is hereby authorized, in its discretion, good and sufficient cause being shown therefor, to remit any fine or fines, penalty or penalties, which any person or persons may have incurred, or may hereafter incur, under any of the provisions of this title; but no fine or penalty shall be remitted for any such violation until the violation shall have been removed."

THE UNIFORM CONTRACT.

FORM OF CONTRACT
ADOPTED AND RECOMMENDED FOR GENERAL USE
BY THE
AMERICAN INSTITUTE OF ARCHITECTS
AND THE
NATIONAL ASSOCIATION OF BUILDERS.

_____
ARCHITECTS.

This Agreement, made the _____ day of _____ in the year one thousand eight hundred and ninety_____ by and between _____ party of the first part (hereinafter designated the Contractor), and _____ party of the second part (hereinafter designated the Owner),

Witnesseth that the Contractor, in consideration of the fulfillment of the agreements herein made by the Owner, agrees with the said Owner, as follows:

ARTICLE I. The Contractor under the direction and to the satisfaction of _____ Architects, acting for the purposes of this contract as agents of the said Owner, shall and will provide all the materials and perform all the work mentioned in the specifications and shown on the drawings prepared by the said Architects for the _____

which drawings and specifications are identified by the signatures of the parties hereto.

ART. II. The Architects shall furnish to the Contractor, such further drawings or explanations as may be necessary to detail and illustrate the work to be done, and the Contractor shall conform to the same as part of this contract so far as they may be consistent with the original drawings and specifications referred to and identified, as provided in Art. I.

It is mutually understood and agreed that all drawings and specifications are and remain the property of the Architects.

ART. III. No alterations shall be made in the work shown or described by the drawings and specifications, except upon a written order of the Architects, and when so made, the value of the work added or omitted shall be computed by the Architects, and the amount so ascertained shall be added to or deducted from the contract price. In the case of dissent from such award by either party hereto, the valuation of the work added or omitted shall be referred to three (3) disinterested Arbitrators, one to be appointed by each of the parties to this contract, and the third by the two thus chosen; the decision of any two of whom shall be final and binding, and each of the parties hereto shall pay one-half of the expenses of such reference.

ART. IV. The Contractor shall provide sufficient, safe and proper facilities at all times for the inspection of the work by the Architects or their authorized representatives. He shall, within twenty-four hours after receiving written notice from the Architects to that effect, proceed to remove from the grounds or buildings all materials condemned by them, whether worked or unworked, and to take down all portions of the work which the Architects shall by like written notice condemn as unsound or improper, or as in any way failing to conform to the drawings and specifications.

ART. V. Should the Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail in any respect to prosecute the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect or failure being certified by the Architects, the Owner shall be at liberty, after _____ days' written notice to the Contractor, to provide any such labor or materials, and to deduct the cost thereof from any money then due or thereafter to become due to the Contractor under this contract; and if the Architects shall certify that such refusal, neglect or failure is sufficient ground for such action, the Owner shall also be at liberty to terminate the employment of the Contractor for the said work and to enter upon the premises and take possession, for the purpose of completing the work comprehended under this contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, and to provide the materials therefor; and in case of such discontinuance of the employment of the Contractor he shall not be entitled to receive any further payment under this contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under this contract shall exceed the expense incurred by the Owner in finishing the work, such excess shall be paid by the Owner to the Contractor, but if such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided, either for furnishing materials or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Architects, whose certificate thereof shall be conclusive upon the parties.

ART. VI. The Contractor shall complete the several portions, and the whole of the work comprehended in this Agreement by and at the time or times hereinafter stated _____

_____

_____

_____

_____

_____

provided that _____

_____

_____

_____

_____

_____

ART. VII. Should the Contractor be obstructed or delayed in the prosecution or completion of his work by the act, neglect, delay or default of the Owner, or the Architects, or of any other contractor employed by the Owner upon the work, or by any damage which may happen by fire, lightning, earthquake or cyclone, or by the abandonment of the work by the employees through no default of the Contractor, then the time herein fixed for the completion of the work shall be extended for a period equivalent to the time lost by reason of any or all of the causes aforesaid; but no such allowance shall be made unless a claim therefor is presented in writing to the Architects within twenty-four hours of the occurrence of such delay. The duration of such extension shall be certified to by the Architects, but appeal from their decision may be made to arbitration, as provided in Art. III of this contract.

ART. VIII. The Owner agrees to provide all labor and materials not included in this contract in such manner as not to delay the material progress of the work, and in the event of failure so to do, thereby causing loss to the Contractor, agrees that he will reimburse the Contractor for such loss; and the Contractor agrees that if he shall delay the material progress of the work so as to cause any damage for which the Owner shall become liable (as above stated), then he shall make good to the Owner any such damage. The amount of such loss or damage to either party hereto shall, in every case, be fixed and determined by the Architects or by arbitration, as provided in Art. III of this contract..

Owner to the Contractor for said work and materials shall be $_____

subject to additions and deductions as hereinbefore provided, and that such sum shall be paid in current funds by the Owner to the Contractor in installments, as follows:

The final payment shall be made within _____ days after this contract is fulfilled.

All payments shall be made upon written certificates of the Architects to the effect that such payments have become due.

If at any time there shall be evidence of any lien or claim for which, if established, the Owner or the said premises might become liable, and which is chargeable to the Contractor, the Owner shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient to completely indemnify him against such lien or claim. Should there prove to be any such claim after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging any lien on said premises made obligatory in consequence of the Contractor's default.

ART. X. It is further mutually agreed between the parties hereto that no certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of this contract, either wholly or in part, and that no payment shall be construed to be an acceptance of defective work or improper materials.

ART. XI. The Owner shall during the progress of the work maintain full insurance on said work, in his own name and in the name of the Contractor, against loss or damage by fire. The policies shall cover all work incorporated in the building, and all materials for the same in or about the premises, and shall be made payable to the parties hereto, as their interest may appear.

ART. XII. The said parties for themselves, their heirs, executors, administrators and assigns, do hereby agree to the full performance of the covenants herein contained.

In Witness Whereof, the parties to these presents have hereunto set their hands and seals, the day and year first above written.

In presence of

_____ SEAL

_____ SEAL

_____ SEAL

_____ SEAL

FORM III.

THE UNIFORM CONTRACT.

FORM OF CONTRACT
ADOPTED AND RECOMMENDED FOR GENERAL USE BY THE
AMERICAN INSTITUTE OF ARCHITECTS
AND THE
NATIONAL ASSOCIATION OF BUILDERS.

AGREEMENT

BETWEEN

_____
Contractor.

AND

_____
Owner.

FOR

_____

AT

_____

_____

DATED

_____ 189__

ARCHITECTS,

_____

_____

AMOUNT OF CONTRACT.

$_____

FORM IV.

Form 3, 1898—A.

DEPARTMENT OF BUILDINGS OF THE CITY OF NEW YORK.

Boroughs of Manhattan and the Bronx.

*Plan No.*_____ NEW BUILDINGS OF 189

STATE OF NEW YORK }
City and County of New York, } *ss.:*

_____, the_____of premises hereinafter described, being duly sworn, deposes and says: That_____ who resides at No._____in the City of _____, in the County of_____ in the State of_____, is the owner in fee of all that certain lot, piece or parcel of land, shown on the diagram annexed hereto and made a part hereof, situate, lying and being in the City and County of New York, known and designated as No._____ _____, and bounded and described as follows, viz.:

BEGINNING at a point on the_____side of_____ distant_____feet_____from the corner formed by the intersection of_____ running thence_____ thence _____ thence _____ thence _____ to the point or place of beginning.

Deponent further says that the_____proposed to be erected upon the said premises in accordance with the accompanying detailed statement in writing of the specifications and plans therefor, will be erected by or on account of the following person , whose full name , residence and interest_____as follows:

_____ No._____
as _____
_____ No._____
as _____
_____ No._____
as _____
_____ No._____
as _____
_____ No._____
as _____
_____ No._____
as _____
_____ No._____
as _____

_____being the only person interested in said proposed_____

Sworn to before me, this }
day of 189 . }

FORM V.

DEPARTMENT OF BUILDINGS OF THE CITY OF NEW YORK.

*Plan No.*_____ **ALTERATIONS OF 189 .**

STATE OF NEW YORK,
City and County of New York, } ss.

_____, *the* _____ *of premises hereinafter described, being duly sworn, deposes and says: That* _____ *who resides at No.* _____ *in the City of* _____, *in the County of* _____ *in the State of* _____, *is the owner in fee of all that certain lot, piece or parcel of land, shown on the diagram annexed hereto and made a part hereof, situate, lying and being in the City and County of New York, known and designated as No.* _____, *and bounded and described as follows, viz.:*

BEGINNING at a point on the _____ *side of* _____ *distant* _____ *feet* _____ *from the corner formed by the intersection of* _____ *running thence* _____ *thence* _____ *thence* _____ *thence* _____ *to the point or place of beginning.*

Deponent further says that the alterations proposed to be made, in the building erected upon the said premises, in accordance with the accompanying detailed statement in writing of the specifications and plans therefor, will be made by or on account of the following person , whose full name , residence and interest _____ *as follows:*

_____ *No.* _____
as _____
_____ *No.* _____
as _____
_____ *No.* _____
as _____
_____ *No.* _____
as _____
_____ *No.* _____
as _____
_____ *No.* _____
as _____

_____ *being the only person interested in said building.*

Sworn to before me, this
day of *189* . }

5- 49 FORM VI.

APPLICATION FOR ERECTION OF BUILDINGS.

Application is hereby made to the Superintendent of Buildings of the City of New York, for the approval of the detailed statement of the specifications and plans herewith submitted, for the erection of the building____herein described. All provisions of the Building Law shall be complied with in the erection of said building____, whether specified herein or not.

(Sign here)_____

NEW YORK,_____189

1. State how many buildings to be erected._____
2. How occupied? If for dwelling, state the number of families._____
3. What is the street or avenue and the number thereof? Give diagram of property._____
4. Size of lot. No. of feet front,_____; No. of feet rear,_____; No. of feet deep,_____
5. Size of building. No. of feet front,_____; No. of feet rear,_____; No. of feet deep,_____ No. of stories in height,_____; No. of feet in height from curb level to highest point of roof beams,_____
6. What will each building cost exclusive of the lot? $_____
7. What will be the depth of foundation walls from curb level or surface of ground?_____
8. Will foundation be laid on earth, sand, rock, timber or piles?_____
9. What will be the base, stone or concrete?_____ If base stones, give size and thickness and how laid._____ If concrete, give thickness._____
10. What will be the sizes of piers?_____
11. What will be the sizes of the base of piers?_____
12. What will be the thickness of foundation walls?_____Of what material constructed?_____
13. What will be the thickness of upper walls? Basement,_____inches; 1st story_____ inches; 2d story,_____inches; 3d story,_____inches; 4th story,_____inches; 5th story,_____inches; 6th story,_____inches; 7th story,_____inches, and from thence to top,_____inches. Of what materials to be constructed?_____
14. State whether independent or party walls._____
15. With what material will walls be coped?_____
16. What will be the materials of front?_____ If of stone, what kind?_____ Give thickness of ashler._____Give thickness of backing in each story._____
17. Will the roof be flat, peaked or mansard?_____
18. What will be the materials of roofing?_____
19. Give size and materials of floor beams. 1st tier,_____; 2d tier,_____; 3d tier,_____; 4th tier,_____; 5th tier,_____; 6th tier,_____; 7th tier,_____; 8th tier,_____; roof tier,_____ State distances from centres. 1st tier,_____inches; 2d tier,_____inches; 3d tier,_____inches; 4th tier,_____inches; 5th tier,_____inches; 6th tier,_____inches; 7th tier,_____inches; 8th tier,_____inches; roof tier,_____inches.
20. If floors are to be supported by columns and girders, give the following information: Size and material of girders under 1st floor,_____under each of the upper floors,_____Size and materials of columns under 1st floor,_____under each of the upper floors,_____
21. If the front, rear or side walls are to be supported, in whole or in part, by iron girders or lintels, give definite particulars._____
22. If girders are to be supported by brick piers and columns, state the sizes of piers and columns._____
23. State by whom the construction of the building is to be superintended._____

FORM VII.

If the Building is to be occupied as an Apartment or Tenement House, give the following particulars.

1. State how many families are to occupy each floor, and the whole number in the house; also, if any part is to be used as a store or for any other business purposes, state the fact, _____

_____

2. What will be the heights of ceilings? 1st story, _____ feet; 2d story, _____ feet; 3d story, _____ feet; 4th story, _____ feet; 5th story, _____ feet; 6th story, _____ feet; 7th story, _____ feet.

3. How are the hall partitions to be constructed and of what materials? _____

_____

4. How many buildings are to be taken down? _____

Owner _____ *Address* _____

Architect _____ *Address* _____

Mason _____ *Address* _____

Carpenter _____ *Address* _____

If a Wall or part of a Wall already built is to be used, fill up the following.

The undersigned gives notice that _____ intend to use the _____ wall of building _____

_____

as party wall in the erection of the building hereinbefore described, and respectfully requests that the same be examined and a permit granted therefor. The foundation wall _____ built of _____ _____ inches thick, _____ feet below curb; the upper wall _____ built of _____ _____ inches thick, _____ feet deep, _____ feet in height.

(Sign here) _____

NOTE.—In making application for the erection of buildings, the following drawings must be furnished: Plans of each and every story, front, rear and side elevations, and longitudinal and transverse sections. All plans must be drawn to a uniform scale, and must be on tracing cloth, properly designated and colored.

THE BUILDING LAW REQUIRES:

1st—That all stone walls shall be properly bonded and laid in cement mortar.

2d—That all skylights having a superficial area of more than nine square feet, placed in any building, shall have the sashes and frames thereof constructed of iron and glass.

3d—That every building which is more than two stories in height above the curb level, except dwelling-houses, hotels, school-houses and churches, shall have doors, blinds or shutters made of iron, hung to iron hanging frames or to iron eyes built into the wall, on every window and opening above the first story thereof, excepting on the front openings of buildings fronting on streets which are more than thirty feet in width. Or the said doors, blinds or shutters may be constructed of pine or other soft wood of two thicknesses of matched boards at right angles with each other, and securely covered with tin, on both sides and edges, with folded lapped joints, the nails for fastening the same being driven inside the lap; the hinges and bolt, or latches shall be secured or fastened to the door or shutter after the same has been covered with the tin, and such doors or shutters shall be hung upon an iron frame, independent of the wood-work of the windows and doors, or two iron hinges securely fastened in the masonry; or such frames, if of wood, shall be covered with tin in the same manner as the doors and shutters.

4th—That outside fire escapes shall be placed on every dwelling-house occupied by or built to be occupied by three or more families above the first story, and every building already erected, or that may hereafter be erected, more than three stories in height, occupied and used as a hotel or lodging house, and every boarding-house, having more than fifteen sleeping-rooms above the basement story, and every factory, mill, manufactory or workshop, hospital, asylum or institution for the care or treatment of individuals, and every building inwhole or in part occupied or used as a school or place of instruction or assembly, and every office building five stories or more in height, all to be constructed as follows:

BALCONIES MUST NOT BE LESS THAN THREE FEET WIDE.

Brackets must not be less than ¼ x 1¾ inches wrought iron, placed edgewise, or 1¾ inch angle iron ¼ inch thick, well braced, and not more than three feet apart, and the braces to brackets must be not less than ¾ inch square wrought iron, and must extend two-thirds of the width of the respective brackets or balconies. In all cases the brackets must go through the wall, and be turned down three inches.

Brackets on New Buildings must be set as the walls are being built. When brackets are to be put on old houses, the part going through the wall shall not be less than one inch diameter, with screw nuts and washers not less than five inches square and ¼ inch thick.

Top Rails.—The top rail of balcony must be 1½ inch x 1½ inch wrought iron or 1½ inch angle iron ¼ inch thick, and in all cases must go through the walls, and be secured by nuts and 4 inch square washers, at least ⅝ inch thick, and no top rail shall be connected at angles by the use of cast iron.

Bottom Rails.—Bottom rails must be 1¼ inch x ¾ inch wrought iron or 1¼ inch angle iron ¼ inch thick, well leaded into the wall. In frame buildings the top rails must go through the studding and be secured on the inside by washers and nuts as above.

Filling-in Bars.—The filling-in bars must be not less than ½ inch round or square wrought iron, placed not more than 6 inches from centres, and well riveted to the top and bottom rails.

Stairs.—The stairs in all cases must be not less than 18 inches wide, and constructed of ¼ x 3½ inch wrought iron sides or strings. Steps may be of cast iron of the same width of strings, or ⅝ inch round iron, double rungs, and well riveted to the strings. The stairs must be secured to a bracket on top and rest on and be secured to a bracket or tread iron bar at the bottom. All stairs must have a ¾ inch hand rail of wrought iron, well braced.

Floors.—The flooring of balconies must be of wrought iron 1¼ x ⅝ inch slats placed not over 1¼ inches apart, and secured to iron battens 1¼ x ⅝ inch, not over three feet apart and riveted at the intersection. The openings for stairways in all balconies shall not be less than 20 inches wide and 30 inches long, and have no covers.

Drop Ladders.—Drop ladders from lower balconies where required shall not be less than 14 inches wide, and shall be made of 1¼ x ⅝ inch sides and ⅝ inch rungs of wrought iron. In no case shall a drop ladder be more than 12 feet in length. In no case shall the ends of balconies extend more than nine inches over the brackets.

Scuttle Ladders.—Ladders to scuttles shall be constructed in all cases the same as the stairs or step-ladders from balconies of fire escapes.

The Height of Railing around balconies shall not be less than two feet nine inches.

No Fire Escape will be approved by the Superintendent of Buildings if not in accordance with above specifications.

In constructing all balcony fire-escapes, the manufacturer thereof shall securely fasten thereto, in a conspicuous place, a cast-iron plate having suitable raised letters on the same, to read as follows: Notice! Any person placing any incumbrance on this balcony is liable to a penalty of ten dollars and imprisonment for ten days.

5th—That all exterior and division or party walls over fifteen feet high, excepting where such walls are to be finished with cornices, gutters or crown mouldings, shall have parapet walls carried two feet above the roof, and shall be coped with stone, well-burnt terra-cotta or cast iron.

6th—That every building and the tops and sides of every dormer-window thereon shall be covered and roofed with slate, tin, copper or iron, or such other quality of fire-proof roofing as the superintendent of buildings, under his certificate, may authorize.

7th—That all exterior cornices shall be fire proof.

8th—That the stone or brick work of all smoke flues, and the chimney shafts of all furnaces, boilers, bakers' ovens, large cooking ranges and laundry stoves, and all fines used for a similar purpose, shall be at least eight inches in thickness. If there is a cast-iron or burnt clay pipe built inside of the same, with one-inch air space all around it, then the stone or brick work inclosing such pipes shall not be less than four inches in thickness.

9th—That before any iron or steel beam, lintel or girder intended to span an opening over ten feet in length in any building, shall be used for supporting a wall, it shall be inspected, *tested and approved* as provided by law.

FORM VIII.

REPORT UPON APPLICATION.

Department of Buildings of the City of New York.

NEW YORK,_____189

To the Superintendent of Buildings:

I respectfully report that I have thoroughly examined and measured the wall____ etc., named in the foregoing application, and found the foundation wall____to be built of_____ inches thick,_____feet below curb, the upper wall____built of_____inches thick, _____feet deep,_____feet in height, and that the mortar in said wall____is_____ hard and good, and that the wall_____built as party wall____and_____in a good and safe condition.

What is the nature of the ground?_____

What kind of sand was used in the mortar?_____

(*The Inspector must here state what defects, if any, are in the wall.*)

(*The Inspector must state the thickness of wall in each and every story.*)

_____

_____

_____

_____

_____

_____

_____

_____*Inspector.*

FINAL REPORT OF INSPECTOR.

NEW YORK,_____189

To the Superintendent of Buildings:

Work was commenced on the within described building on the_____day of_____18 and completed on the_____day of_____189____, and all the iron and steel girders, beams and columns are properly set, and of size as per application, and all the work upon said building has been done in accordance with the foregoing detailed statement, except as noted below.

Respectfully submitted,

_____*Inspector.*

REMARKS.

_____

_____

_____

_____

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_____

_____

_____

FORM IX.

Department of Buildings,

CITY OF NEW YORK.

Detailed Statement of Specifications

FOR

NEW BUILDINGS.

*No.*_____ *Submitted*_____ *189*

LOCATION.

_____

_____

*Owner*_____

*Architect*_____

*Builder*_____

*Received by*_____ *189*

*Returned by*_____ *189*

*Report*____ *favorable.*

*Referred to Inspector*_____

_____ *189*

*Returned*_____ *189*

_____

Inspector.

NEW YORK,_____ 189

This is to certify that I have examined the within detailed statement, together with the copy of the plan relating thereto, and find the same_____ to be in accordance with the provisions of the laws relating to buildings in the City of New York; that the same has been_____ approved, and entered in the record of the Department of Buildings.

_____

Superintendent of Buildings.

FORM X.

Applicant must indicate the Building Line or Lines clearly and distinctly on the Drawings.

Plan No._____

APPLICATION TO ALTER, REPAIR, Etc.

Application is hereby made to the Superintendent of Buildings of the City of New York, for the approval of the detailed statement of the specifications and plans herewith submitted, for the alteration or repair of the building___herein described. All provisions of the Building Law shall be complied with in the alteration or repair of said building___, whether specified herein or not.

(Sign here)_____

New York,_____189

1. State how many buildings to be altered._____
2. What is the street or avenue and the number thereof? Give diagram of property._____
3. How much will the alteration cost? $_____

GIVE THE FOLLOWING INFORMATION AS TO THE PRESENT BUILDING:

1. Size of lot on which it is located, No. of feet front,_____; feet rear,_____; feet deep,_____
2. Size of building, No. of feet front,_____; feet rear,_____; feet deep,_____No. of stories in height,_____; No. of feet in height from curb level to highest point of beams,_____
3. Material of building,_____; material of front,_____
4. Whether roof is peak, flat, or mansard,_____
5. Depth of foundation walls_____feet; thickness of foundation walls,_____; materials of foundation walls,_____
6. Thickness of upper walls,_____inches. Material of upper walls,_____
7. Whether independent or party walls,_____
8. How the building is or was occupied,_____

IF TO BE RAISED OR BUILT UPON, GIVE THE FOLLOWING INFORMATION:

1. How many stories will the building be when raised?_____
2. How high will the building be when raised?_____
3. Will the roof be flat, peak, or mansard?_____
4. What will be the thickness of wall of additional stories?_____story,_____inches;_____ story,_____inches.
5. Give size and material of floor beams of additional stories;_____1st tier,_____,_____x_____ _____2d tier,_____,_____x_____. Distance from centres on_____tier,_____ inches;_____tier_____inches.
6. How will the building be occupied?_____

IF TO BE EXTENDED ON ANY SIDE, GIVE THE FOLLOWING INFORMATION.

1. Size of extension, No. feet front,_____; feet rear,_____; feet deep,_____; No. of stories in height,_____; No. of feet in height,_____.
2. What will be the material of foundation walls of extension? _____. What will be the depth? _____feet. What will be the thickness? _____inches.
3. Will foundation be laid on earth, sand, rock, timber or piles? _____

IF TO BE EXTENDED ON ANY SIDE GIVE THE FOLLOWING INFORMATION.

4. What will be the base, stone or concrete?_____ If base stones, give size and thickness and how laid,_____ If concrete, give thickness,_____

5. What will be the sizes of piers?_____ What will be the sizes of the base of piers?_____

6. What will be the thickness of upper walls? 1st story,_____ inches ; 2d story_____ inches 3d story,_____ inches ; 4th story,_____ inches ; 5th story,_____ inches 6th story,_____ inches ; 7th story,_____ inches ; from thence to top,_____ inches and of what materials to be constructed,_____

7. State whether independent or party-walls._____ If party-walls give thickness thereof._____

8. With what material will walls be coped?_____

9. What will be the materials of front?_____ If of stone, what kind?_____ Give thickness of front ashlar._____ Give thickness of backing._____

10. Will the roof be flat, peaked or mansard?_____

11. What will be the materials of roofing?_____

12. Give size and material of floor beams, 1st tier,_____, _____ x _____; 2d tier,_____ x _____; 3d tier,_____, _____ x _____; 4th tier,_____, _____ x _____ 5th tier,_____, _____ x _____; 6th tier,_____, _____ x _____; 7th tier,_____ x _____; roof tier,_____, _____ x _____ State distance from centres on 1st tier,_____ inches ; 2d tier,_____ inches ; 3d tier,_____ inches ; 4th tier,_____ inches ; 5th tier _____ inches ; 6th tier,_____ inches ; 7th tier,_____ inches ; roof tier,_____ inches

13. If floors are to be supported by columns and girders, give the following information : Size and materia of girders under 1st floor,_____, _____ x _____ under each of the upper floors,_____ Size and material of columns under first floor _____ under each of the upper floors,_____

14. If the front, rear or side walls are to be supported, in whole or in part, by iron girders or lintels, give definite particulars,_____

15. If girders are to be supported by brick piers and columns, state the size of piers and columns _____

16. How will the extension be connected with present or main building?_____

17. How will the extension be occupied? If for dwelling purposes, state how many families are to occupy each floor._____

18. State who will superintend the alterations._____

IF ALTERED INTERNALLY, GIVE DEFINITE PARTICULARS AND STATE HOW THE BUILDING WILL BE OCCUPIED :

_____

IF THE FRONT, REAR, OR SIDE WALLS, OR ANY PORTION THEREOF, ARE TO BE TAKEN OUT AND REBUILT, GIVE DEFINITE PARTCULARS, AND STATE IN WHAT MANNER :

_____

Plan No._____B, 189 . Filed_____189 .

NOTICE.—This permit expires by its own limitation six months from date of approval of the plan by the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx.

THOMAS J. BRADY,
Commissioner of Buildings for the Boroughs of Manhattan and the Bronx.

SPECIFICATIONS

FOR THE

PLUMBING AND DRAINAGE

OF THE BUILDINGS HEREIN DESCRIBED.

Location _____

_____

Number of Buildings_____ Description of Buildings_____

Dimensions of each Building_____ Dimensions of each Lot_____

Owner_____ Address_____

Architect_____ Address_____

Plumber _____ Address_____

	Cellar.	Basement.	First Story.	Second Story.	Third Story.	Fourth Story.	Fifth Story.	Sixth Story.	Seventh Story.
Number of families on each floor.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Pursuant to the requirements of law, the accompanying plans for the plumbing and drainage of each of the above-mentioned buildings, and the following description thereof, is hereby submitted for the approval of the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx, the undersigned hereby agreeing to cause the work to be done and the material to be furnished in accordance therewith, with such modifications as may be required by the said Commissioner of Buildings. No modifications of the plans, or of the work described herein, will be made, unless the same is previously allowed by the said Commissioner of Buildings, on the written application of Owner or Architect; and all work pertaining to the proper plumbing and drainage of the buildings and premises which is not covered by the plans, but is found necessary during the progress of the work in order to carry into effect the true intent thereof, will be executed in accordance with the directions of the said Commissioner of Buildings.

Drawings and specifications constitute plans. Rules and regulations to be part of specifications.

It is expressly understood that these specifications and the drawings submitted herewith to the Department of Buildings for the Boroughs of Manhattan and The Bronx, for approval, constitute together, as approved by said Commissioner of Buildings, the plans for the plumbing and drainage of the buildings herein described; and in respect to all work not covered thereby, the Plumber is to be governed by the Rules and Regulations as to plumbing and drainage established by the said Commissioner of Buildings.

Privy vault and Cesspool—Material _____ Dimensions, ____ x ____ x ____

How made water-tight? _____

Location _____ Distance from building _____ feet.

Private sewer—Material _____ Diameter _____ inches.

Where does it discharge? _____

How many buildings now connect with it? _____

Fall per foot _____ inch. Length _____ feet.

Old sewers—If old sewer is to be used, state its diameter and character _____

_____

House sewers—State number for each building _____ Diameter _____ inches.

Material _____ Fall per foot _____ inch.

Where connected? _____

House traps—Material _____ Diameter _____ inches.

Fresh-air inlets—State number for each building _____ Diameter _____ inches.

Material _____ Location of inlet _____

How will they be protected against obstructions? _____

_____

House drains—State number for each building _____ Diameter _____ inches.

Material _____

Area shaft, court and yard drains—Material _____ Diameter _____ inches.

How trapped? _____

Cellar drain—Material _____ Diameter _____ inches.

How trapped? _____

How will the yard, area, shaft, court and cellar drains be protected against obstructions? _____

Catch basins—Where located? _____ Material _____

How will they be made water-tight? _____

Dimensions, ____ x ____ x ____

Sub-soil drains—Material _____ Where connected? _____

How arranged to maintain permanent trap seal? _____

_____

_____

Floor, stable and stall drains—Material _____ Diameter _____ inches.

How trapped? _____

Material of soil, waste and vent pipes _____

Soil pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Waste-pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Vent-pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Refrigerator waste-pipes—State number in each building _____ Diameter _____ inches.

Material _____

Will they extend through roof? _____

Roof drainage—State number of outside leaders _____ Material _____

Diameter _____ inches. Diameter of traps _____ inches.

State number of inside leaders _____ Material _____

Diameters _____ Diameter of traps _____ inches.

How will all the above soil, waste, vent and other pipes be supported? _____

_____

Sinks—Material _____ Where located? _____

Diameter and material of safe waste-pipe _____

Drip trays—Material _____ Where located? _____

Water-closet cisterns—Material _____ Dimensions, ____ x ____ x ____

Diameter and material of supply-pipe _____ inches.

Diameter and material of flush-pipe _____ inches.

House-tank—Material _____. Dimensions, ____ x ____ x ____

Where located? _____

Overflow pipe, where discharged? _____

Emptying pipe, where " _____

Tell-tale pipe, where " _____

Pump—Is a pump necessary? _____

Where will it be located? _____

State character of same? _____

Fixtures—Where located:

	Yard.	Cellar.	Basement.	First Story.	Second Story.	Third Story.	Fourth Story.	Fifth Story.	Sixth Story.	Seventh Story.	Eighth Story.	Ninth Story.	Tenth Story.	Eleventh Story.	Twelfth Story.	Thirteenth Story.	Fourteenth Story.	Fifteenth Story.	Sixteenth Story.	Seventeenth Story.	Eighteenth Story.	Nineteenth Story.	Twentieth Story.
Water-closets																							
Urinals																							
Wash-basins																							
Bath-tubs																							
Wash-tubs																							
Sinks																							

Description of water-closets _____

Description of urinals _____

Description of wash-basins _____

Description of bath-tubs _____

Description of wash-tubs _____

Description of sinks _____

Water supply—Will all fixtures be water supplied? _____

Give general description and character of same _____

NOTE.—On this and the next two pages of the original permit, are printed the rules and regulations of the department with regard to Plumbing, Drainage, etc.

Then follows, on the fourth page from this, the blank shown in Form XVI, upon which the Inspector makes his report at the completion of the job.

FINAL REPORT.

NEW YORK, _____, 189

To the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx:

SIR—I beg to report that the work of plumbing and drainage herein described was begun on the _____ day of _____, 189__, and completed on the _____ day of _____, 189__, and that said work was carefully examined by me and found to conform in all respects to the approved plans and specifications and the Rules and Regulations of the Department of Buildings for the Boroughs of Manhattan and The Bronx.

Respectfully submitted,

_____

Inspector, _____ *District.*

REMARKS.

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FORM XVI.

REPORT ON EXAMINATION

OF

Plan No._____189__, B.

NEW YORK_____189__.

To the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx:

SIR—I have the honor to report that I have carefully examined the accompanying drawings and these specifications, and found that they_____conform to regulations for the following reasons:

_____

_____

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FORM XVII.

Department of Buildings of the City of New York.

BOROUGHS OF MANHATTAN AND THE BRONX.

Plan No._____**189 . Filed**_____**189 .**

NOTICE.—In making application for the approval of plans for light and ventilation of new tenement and lodging houses, or for alterations of existing tenement or lodging houses, the following drawings must be furnished: Plans of all floors, including cellar and basement, and, if necessary, transverse and longitudinal sections. All plans must be drawn to a uniform scale, not less than one-quarter inch to the foot, and be on tracing cloth or cloth prints, and each shaft or court properly designated and dimensions of same plainly marked thereat.

NOTICE.—This permit expires by its own limitation six months from date of approval of the plan by the Commissioner of Buildings, unless the building is then begun.

THOMAS J. BRADY,
Commissioner of Buildings.

APPLICATION

TO THE

COMMISSIONER OF BUILDINGS

TO APPROVE PLANS FOR LIGHT AND VENTILATION OF PROPOSED TENEMENT OR LODGING HOUSE.

Pursuant to law, application is hereby made to the Commissioner of Buildings to approve plans herewith submitted for light and ventilation of the buildings described in the following specifications, which are made part of said plans. The plans and specifications are to be construed together, but in case of any difference between them these specifications, subject to such conditions as may be imposed by the Commissioner of Buildings, are to govern.

Location_____Number of Buildings_____

Owner _____Address_____

Architect_____Address_____

Dimensions of each Lot_____

Dimensions of each Building_____

Dimensions of each Extension_____

Number of floors above cellar or basement of main building_____of extension_____

If it is proposed to alter an existing tenement or lodging house, or to convert a dwelling house or other building into a tenement or lodging house, state in what particulars:

_____

_____

_____

_____

_____

_____

FORM XVIII.

Cellar—How to be occupied?_____

Basement—How to be occupied?_____

Cellar ceiling—Height above sidewalk_____

Basement ceiling—Height above sidewalk_____

	Cellar.	Basement.	1st floor.	2d floor.	3d floor.	4th floor.	5th floor.	6th floor.	7th floor.
How many families will occupy each floor									
Height of ceilings									
Number of living rooms opening on shafts and courts									
Number of living rooms opening on street and yard									

Halls—How lighted and ventilated?_____

State dimensions of ventilating skylight over main hall_____

Dimensions of windows for living rooms_____

Dimensions of windows for water-closet apartments_____

Dimensions of fanlights over doors of living rooms where marked on plans_____

Cellar—How lighted and ventilated?_____

Basement—How lighted and ventilated?_____

" How made water-tight?_____

Cellar—How lighted and ventilated?_____

" How made water-tight?_____

Will cellar or basement ceiling be plastered?_____

What additional structure, if any, will be on lot?_____

Distance from extreme rear of main building to rear line of lot._____

Distance from extreme rear of extension to rear line of lot_____

	Cellar.	Basement.	1st floor.	2d floor.	3d floor.	4th floor.	5th floor.	6th floor.	7th floor.
Number and location of water-closets									

How will the floor and sides of water-closet apartments be made water-tight?_____

How will water-closet apartments be ventilated?_____

FORM XIX.

DIMENSIONS OF LOT, SHAFTS, COURTS, YARDS, ETC.

NOTE.—If several buildings and lots are of same dimensions throughout, one statement is sufficient. ALL COMPUTATIONS MUST BE MADE ON LEVEL OF FIRST STORY. SHAFTS LESS THAN TWENTY-FIVE SQUARE FEET IN AREA WILL NOT BE COMPUTED AS UNCOVERED SPACE.

NOTE.—Section 661, Laws 1887, as amended 1895, restricts the occupancy of any tenement or lodging house on any ordinary city lot to sixty-five per centum of the area of said lot, when such lot is not a corner lot, and empowers the Commissioner of Buildings to extend such occupancy to seventy-five per centum of the area of the aforesaid lot, provided "*the light and ventilation of such tenement or lodging house are, in the opinion of the Commissioner of Buildings, materially improved.*" The same section also provides that no tenement or lodging house shall occupy more than ninety-two per centum of the area of a corner lot above the first story.

The limiting percentages that will be allowed under this provision of law is as follows:

Up to 80 feet	75 per cent.	Up to 120 feet	67 per cent.
" 90 "	73 "	" 130 "	
" 100 "	71 "	and above	65 per cent.
110 "	69 "		

For corner buildings upon lots less than 50 feet frontage, the maximum area that may be covered will be determined as follows.

Up to 80 feet	92 per cent.	Up to 120 feet	84 per cent.
" 90 "	90 "	" 130 "	82 "
" 100 "	88 "	" 140 "	80 "
" 110 "	86 "	" 150 "	78 "

For buildings greater than 50 feet frontage, the former tables of percentages will apply to that part which is in excess of 50 feet, and the latter scale for that which is under 50 feet.

While the uncovered area cannot be less than the above it must be greater where required by the further regulations for shafts and fixing distance required at rear.

HOUSE No. 1.		HOUSE No. 2.		HOUSE No. 3.	
	Sq. Ft.		Sq. Ft.		Sq. Ft.
Shaft No. 1,	x =	No. 1,	x =	No. 1,	x =
" 2,	x =	" 2,	x =	" 2,	x =
" 3,	x =	" 3,	x =	" 3,	x =
" 4,	x =	" 4,	x =	" 4,	x =
Court No. 1,	x =	Court No. 1,	x =	Court No. 1,	x =
" 2,	x =	" 2,	x =	" 2,	x =
Front Yard,	x =	Front Yard,	x =	Front Yard,	x =
Rear Yard,	x =	Rear Yard,	x =	Rear Yard,	x =
Alley Yard,	x =	Alley Yard,	x =	Alley Yard,	x =
Total area of Shafts, etc.		Total area of Shafts, etc.		Total area of Shafts, etc	
House,	x =	House,	x =	House,	x =
Lot,	x =	Lot,	x =	Lot,	x =
Per cent. of lot covered		Per cent. of lot covered,		Per cent. of lot covered	

Remarks _____

And it is further understood by the owner and architect that these plans for light and ventilation of the above-described buildings are approved, and this permit is issued and accepted upon the following conditions in addition to the foregoing, and are hereby incorporated therewith, according as the same is a tenement or lodging house.

Strict adherence to plans required.

That strict adherence to the plans and specifications on which this permit is granted will be required by the Commissioner of Buildings unless permission in writing has been previously given by him allowing their modification.

Cellars, permit to occupy as a dwelling.

That no part of the cellar or basement will be constructed during the erection or after the completion of these buildings, to be occupied wholly or in part as a dwelling, unless the same be approved herein, or a special permit in writing has been previously obtained from the Commissioner of Buildings, nor unless the same comply with the

Conditions necessary to obtain permit.

following conditions: 1st. That it be at least seven feet in height in every part. 2d. That the ceiling thereof be at least two feet above the street or curb. 3d. That the space beneath the floor is cemented; and, 4th. That the area extend along the full frontage thereof and be at least two feet six inches wide, six inches below the floor level of the part occupied, and properly graded and drained, and that the steps leading thereto will have open risers and be so arranged as not to obstruct the light and ventilation thereof.

Air space required.

That no habitable room will have a smaller air space than six hundred cubic feet.

Windows.

That every habitable room and water-closet apartment will have a window opening directly upon the street, yard, shaft or court, and such windows will be at least twelve square feet in area for living rooms, and three square feet in area for water-closet apartments, measured between the stop-beads. Said window will be hung with weights and made to slide vertically; and, in addition, each room, except those opening upon the

Transoms.

public halls, will have a ventilating or transom window so arranged as to produce a cross-current of air.

Alcove rooms.

Alcove rooms will conform to all the requirements of ordinary rooms.

Area of shafts and courts.

Except as hereinafter otherwise stated, every light and air shaft or court for habitable rooms will be at least twenty-five feet square in area up to and including five stories in height, and be increased five square feet in area for each additional story beyond the fifth, and not less than two feet four inches wide in the clear at every point up to and including five stories in height and be increased four inches in width for each additional story beyond the fifth. Shafts or courts between two houses, and common to both, will be double this area and not less than four feet eight inches wide up to and including five stories in height and be increased eight inches in width for each additional story beyond the fifth. Where there are five interior rooms in a line on a floor the area of each shaft or court will be fifty per cent. greater than above described, and where there are six interior rooms in a line on a floor the area of such shaft or court will be at least one hundred per cent. greater than the minimum above stated.

Increased areas of shafts and courts.

Where there are twelve rooms on a floor of a tenement-house erected on an ordinary city lot, except a corner lot, the shafts and courts to light and ventilate the interior rooms will have an area equal to two hundred and fifteen square feet, and where there are fourteen rooms on a floor of a similar tenement-house the area of such shafts and courts will not be less than two hundred and sixty-five square feet, and these shafts or courts will be

Where shafts will be enlarged.

enlarged at their central portion so as to provide windows at the ends of each set of rooms where there are front and rear sets of apartments on a floor.

Shafts in corner houses.

In every corner house on an ordinary city lot having four families on a floor, and six rooms on the inside portion thereof the shaft to light and ventilate interior rooms will have an area equal to one hundred and seven and one-half square feet; and where there are seven rooms the area of such shaft will be one hundred and thirty-two and one-half square feet, and these shafts will be enlarged at their central portions to provide end windows as above described.

Shafts to be free from obstructions

All shafts over ten square feet in area will be free and clear from skylights or any other covering or obstruction at the top, and all shafts and courts will be of the same area throughout.

Ventilating skylight.

That the main hall will be lighted and ventilated by a sky-light provided with louvres or ridge ventilator.

Space at rear.

At the rear of every tenement or lodging house on any lot other than a corner lot there will be and remain from the ground upward a clear space of not less than ten feet between it and the rear end of the lot. At the rear of every tenement or lodging house on any corner lot there shall be and remain above the first story a clear space of not less than five feet between it and the rear end of the lot, up to eighty feet in height and

Over 80 feet, five feet four inches.	Over 120 feet, eight feet.
" 85 " five feet eight inches.	" 125 " eight feet four inches.
" 90 " six feet.	" 130 " eight feet eight inches.
" 95 " six feet four inches.	" 135 " nine feet.
" 100 " six feet eight inches.	" 140 " nine feet four inches.
" 105 " seven feet.	" 145 " nine feet eight inches.
" 110 " seven feet four inches.	" 150 " ten feet.
" 115 " seven feet eight inches.	

Where the width of a corner lot is greater than an ordinary city lot it will have a clear space of not less than ten feet in the rear of that portion in excess of an ordinary city lot, or, in lieu thereof, an open court not less than one of the same widths as above, and beginning at the street or avenue, which will extend the full width of the lot and continue to the first interior room. And such interior portion of a corner tenement or lodging house will conform to all the requirements of a tenement or lodging house situated on an inside lot.

Privy vault.

No privy vault or cesspool will be maintained on the premises if a connection with any public sewer can be made.

Water-closets.

The general water-closet accommodations will not be placed in the cellar and no water-closet will be placed in the yard. In tenement houses there will be one water-closet on each floor, and where there is more than one family on a floor there will be one additional water-closet on that floor for every two additional families.

In lodging houses there will be one water-closet on each floor, and where there is more than fifteen persons on any floor there will be an additional water-closet on that floor for every additional fifteen persons or fraction thereof.

Floor and sides of water-closet apartment.

That the floor and sides of each water-closet apartment in every tenement and lodging house will be made water-proof with some non-absorbent material.

Water supply.

In every tenement house connected with any public sewer, running water will be provided over a sink in each set of apartments.

Isolation room.

Each lodging house will be provided with an isolation room, arranged as follows: 1st. It will be located on the uppermost floor and its air space will not be less than one thousand cubic feet. 2d. It will have a window opening on the street or avenue and a louvred skylight on the roof. 3d. It will be provided with a water-closet apartment having its partitions extended to ceiling and a window opening on the outer air, also a sink with running water; and, 4th. The walls and floor will be rendered impermeable to liquids or gases.

Drains, etc.

Yards, areas, light-shafts and courts will be properly graded, flagged or concreted and drained.

Restrictions.

Where the premises are occupied as a tenement house no part thereof will be used for a lodging house or private school. Nor will they be used for the storage and handling of rags.

No stable or coal yard will be maintained on any lot whereon it is proposed to erect a tenement or lodging house or convert any building to the purposes of a tenement or lodging house.

And, finally, the undersigned hereby agrees to faithfully comply with all the laws relating to the erection of tenement or lodging houses, or to the conversion of other buildings to the purposes of a tenement or lodging house, or to the maintenance of such tenement or lodging house, and also the rules and regulations under which this permit is issued.

_____

Owner.

_____

Architect.

Dated_____189__.

These plans and specifications were referred to Inspector_____

_____District, on the_____day of_____, 189 .

_____Clerk.

FINAL REPORT.

NEW YORK,_____, 189 .

To the Commissioner of Buildings:

SIR—I have the honor to report that the above described premises were begun on the_____day of_____, 189__, and completed on the_____ day of_____, 189__, and that said premises conform in all respects to the conditions of the above permit and also the laws and rules and regulations relating to the light and ventilation of tenement and lodging houses.

Respectfully submitted,

_____

*Inspector,*_____*District.*

FORM XXII.

REPORT ON EXAMINATION

OF

Plan No._____189_.

NEW YORK,_____189_.

To the Commissioner of Buildings:

SIR—I have the honor to report that I have carefully examined the accompanying drawings and these specifications, and found that they_____conform to the laws and the rules and regulations relating to the light and ventilation of tenement and lodging houses:

FORM XXIII.

A SERIES

OF

QUESTIONS AND EXAMPLES

RELATING TO THE SUBJECTS
TREATED OF IN THIS VOLUME.

It will be noticed that the various Question Papers in this volume are numbered to correspond with the sections to which they refer, the section numbers being placed on the headline opposite the page number, as in the preceding sections. As in the case of the Instruction Papers, each section is complete in itself, the page numbers and question numbers beginning with (1) for each section.

HISTORY OF ARCHITECTURE.

(ARTS. 1–178. SEC. 20.)

(1) (*a*) What were the characteristic features of the feudal castles? (*b*) What rooms in the modern house plan are derived from the "great hall" of the castle?

(2) What is the name of the curved line by which the shafts of the Greek columns were diminished?

(3) What two Roman architects wrote treatises on the "Five Orders of Architecture"?

(4) What are the three general principles of construction upon which all architectural styles are based?

(5) (*a*) How many temples are united in the structure known as the Erechtheum? (*b*) Are their entrances on the same level?

(6) Describe the approach to the entrance of an Egyptian temple.

(7) How did architecture originate?

(8) Who was the architect of Trinity Church, Boston?

(9) (*a*) In what structure does the only perfect example of the Grecian-Corinthian column exist? (*b*) What was the height of the Corinthian column? (*c*) Into how many flutes is the shaft divided?

(10) Has the architecture of Egypt, Assyria, and Persia exercised much influence on that of Western nations?

(11) What is a baptistry?

(12) (*a*) When was the foundation stone of the United States Capitol laid? (*b*) When was the building finished? (*c*) Under whose supervision?

(13) From what class of mankind does a community originate?

(14) How many original styles of architecture are there?

(15) What are the general characteristics of French Renaissance architecture?

(16) What is meant by the term astylar?

(17) To what architectural style does the Hôtel des Invalides belong?

(18) Where did the Christians first hold services of worship?

(19) Describe the term *character* as applied to a building.

(20) What was the name of the order in which female figures were employed?

(21) What prominent American building was designed to resemble the Cathedral of Seville?

(22) In what form of structure did Greek architecture reach its fullest development?

(23) (*a*) What style of architecture is represented in the Church of the Madeline? (*b*) What American building resembles it somewhat?

(24) What are the characteristics of the Louis XIV period of French architecture?

(25) What nations made use of lintels to span openings?

(26) What characteristic differences are there between the Renaissance architecture of France and that of Italy?

(27) Of what is the Florentine school of Italian Renaissance most expressive?

(28) (*a*) Give the names of the Grecian orders. (*b*) Name the three principal parts of each order.

(29) For what purposes are buttresses required?

(30) Describe the châteaux of the Francis I period of French architecture.

(31) What is the most characteristic detail of all Gothic construction?

(32) What are the most interesting monuments of the French Renaissance?

(33) (*a*) What was the Acropolis at Athens? (*b*) How many gateways did it have? (*c*) What was the name of the principal one?

(34) (*a*) What is an entablature? (*b*) What are the names of the parts into which it is divided?

(35) Why were flying buttresses introduced?

(36) What does Pelasgic architecture present to us?

(37) Describe in detail the theory of Gothic construction.

(38) Describe in detail the theory of Byzantine construction.

(39) How was the apparent depression in the cornices of the Grecian temples obviated?

(40) From what source did the Greeks derive the design of the Doric order?

(41) In what respect do French cathedral doorways differ from those in England?

(42) (*a*) When huge pieces of stone were used in masonry, by what name was it known to the Greeks? (*b*) Why was it so called?

(43) What are the fundamental principles of Gothic construction?

(44) What were the first three edifices erected solely for the purpose of Christian worship?

(45) Where do we find the first examples of the voussoired arch in Europe?

(46) What important structures were erected in the mediæval period besides the cathedrals?

(47) What are the most important architectural monuments of Egypt?

(48) (*a*) From what source did the Romans get their ideas for early architectural works? (*b*) Where did they borrow their later ideas?

(49) Describe the characteristics of the Venetian Gothic style.

(50) When and where did the Flamboyant style flourish?

(51) Describe the characteristics of the French Renaissance during the Henry IV period.

(52) What is meant by the term *placing columns in antis?*

(53) Why is the character of Gothic architecture in Italy different from that of northern Europe?

(54) How were openings covered in the walls of cyclopean masonry?

(55) To what country do we turn for the beginnings of architecture?

(56) What was Romanesque architecture?

(57) (*a*) When is a temple called *peristylar?* (*b*) When is it said to be *dipteral?*

(58) What is the principal Gothic cathedral in Italy?

(59) What difficulties were overcome by use of the pointed arch?

(60) Name two Byzantine churches in western Europe.

(61) What difficulties present themselves in building a Roman groined vault over an oblong space?

(62) What is the finest Renaissance palace in Rome?

(63) (*a*) What is a triglyph? (*b*) What does it represent?

(64) Who designed the Cathedral of St. Paul in London?

(65) Where do we find the first trace of Renaissance architecture in England?

(66) (*a*) What is plate-tracery? (*b*) What is bar tracery? (*c*) To what period does each belong?

(67) Can the attempt to Romanize the Greek orders be considered a success?

(68) What buildings represent in America the period of the Classic Revival?

(69) Describe a Hathor-head capital.

(70) Of what period is the ball-flower ornament characteristic?

(71) (*a*) What is a *metope?* (*b*) For what purpose did the metope originally exist? (*c*) How were the metopes treated in later work?

(72) What are the general characteristics of French Renaissance architecture?

(73) What is the most prominent Grecian building in the Ionic order?

(74) What is a transept?

(75) What is an atrium?

(76) What are the names and dates of the three periods of Gothic architecture in Great Britain?

(77) What is the distinction between the architecture of the Renaissance and that of the Revival period?

(78) What French château possesses examples of design embracing the three principal periods of the French Renaissance?

(79) Why were the columns in Egyptian architecture so closely placed?

(80) Name two representative buildings of the Classic Revival period in France, in Germany, and in England.

(81) What is a pediment?

(82) What are the three periods of Renaissance architecture in France?

(83) (*a*) What was the largest Roman amphitheater? (*b*) What was its capacity?

(84) With what feeling is the Parthenon regarded by the entire art world?

(85) When and by whom was the Italian school of Renaissance architecture founded?

(86) By what other name is the architecture of the Louis XIV period known?

(87) What American building represents the period of English Gothic Revival?

(88) What is the most important building in Great Britain in the Revived Gothic style?

(89) When and where did American architecture reach its climax?

ARCHITECTURAL DESIGN.

(ARTS. 1–131. SEC. 21.)

(1) What is the architectural purpose of moldings?

(2) In composing the design of any building, how should we consider the plan in relation to the other drawings?

(3) In modern work should the proportions and details of an order be followed exactly?

(4) What peculiarities are observed in the Doric order as used in the Theater Marcellus at Rome?

(5) What proportion should exist between the trim and the opening of a monumental doorway?

(6) What were the three original Greek orders?

(7) (*a*) What is the height of the pedestal of an order in comparison with the length of the column? (*b*) What is the height of the entablature?

(8) What method of plan drawing is usually followed in the offices of the best architects?

(9) What gave rise to the invention of the Composite order?

(10) Describe the structural difference between the Greek and Roman systems of ornamentation.

(11) How does architectural design differ from design in the mechanic arts?

(12) What detail of the Greek Doric is retained at the present day as characteristic of the order?

(13) What three principles do the elements of beauty embrace?

(14) What is meant by (*a*) *axial symmetry?* (*b*) *balance?*

(15) If the total height, including pedestal, column, and entablature, is 12 ft. 8 in., what is the diameter of the column (*a*) in the Doric order? (*b*) in the Ionic order?

(16) By what is the student furnished with a standard of classic architectural proportion?

(17) How should a group of four or more members be treated in architectural composition?

(18) (*a*) Where did the Grecian-Doric order attain the zenith of its perfection? (*b*) Where, the Ionic order?

(19) What are (*a*) triglyphs? (*b*) mutules? (*c*) guttæ?

(20) (*a*) Describe the outline of a cyma-recta molding. (*b*) On what part of a structure is it generally found?

(21) What is a "bird's-beak" molding?

(22) Describe the form of the round columns of the Norman period.

(23) What three considerations must be satisfied before we take the first step in the composition of a design?

(24) What is meant by *unity* in architectural design?

(25) What is characterized as a monumental plan?

(26) (*a*) What is the characteristic feature of the Greek-Ionic order? (*b*) How many flutes has its column?

(27) What is the most perfect design in Greek architecture?

(28) (*a*) How many different moldings exist in classic architecture? (*b*) What are their names?

(29) What branch of mathematics is largely influential in determining the proportions of the medieval cathedrals?

(30) (*a*) In Gothic architecture, upon what did the architects depend to produce architectural effect? (*b*) How did Classic and Renaissance architecture differ from this?

(31) Give two examples of architectural edifices illustrated in *History of Architecture*, whose composition expresses a group of two.

(32) The difference of impression felt on entering French and English cathedrals, is due to what?

(33) To what does the architectural term *order* refer?

(34) (*a*) Were the Roman moldings enriched as artistically as the Greek? (*b*) What was the difference?

(35) How do the contours of the Greek moldings differ from the Roman?

(36) What term is given to the openings in Gothic windows?

(37) What is the fundamental beauty of a noble building?

(38) What is the element of real importance in the Byzantine style of design?

(39) Name two buildings, illustrated in *History of Architecture*, each of whose masses gives an expression of *unity*.

(40) What are the divisions between the openings of Gothic windows called?

(41) (*a*) How many classes of Greek moldings are there? (*b*) Describe each.

(42) What resources have we at our command that contribute to the expression of artistic taste in a composition?

(43) Describe the flutes of the Greek-Corinthian order.

(44) (*a*) Of what does an architectural order consist? (*b*) To what is it subject? (*c*) By what is it regulated?

(45) In early Gothic buildings, what relation does ornament bear to the construction?

(46) (*a*) What is intercolumniation? (*b*) What details of the Doric order affect the intercolumniation? (*c*) Why?

(47) What characteristics are imparted to a composition through its treatment with reference to light and shade?

(48) (*a*) What orders did the Romans add when they adopted the Greek system? (*b*) Whence were they derived?

(49) (*a*) What Grecian-Doric monument has no triglyphs in the frieze? (*b*) What is substituted for the triglyphs?

(50) In a group of classic moldings, for what purpose is the *fillet* used?

(51) With what instrument or tool were the early Norman moldings executed?

(52) When is it desirable to use pedestals under columns?

(53) What is meant by *breadth* and *dignity* in a design?

(54) Why was an alteration of the Greek orders necessary before they could be adopted by the Romans?

(55) Define the difference between (*a*) *delicacy or prettiness*, (*b*) *beauty*, and (*c*) *grandeur, or magnificence* in architecture.

(56) What are the names of the principal details of Gothic moldings?

(57) (*a*) What is a pilaster? (*b*) When are the sides of a pilaster diminished with entasis?

(58) What works of architecture are celebrated for their beauty of proportion exclusive of ornament?

(59) How did the Romans alter the Doric order?

(60) What are *antæ?*

(61) What building illustrated in *History of Architecture* derives its beauty from a large area of lighted surface, without any important shadows to break it?

(62) What is an arcade?

(63) How did the French and English architects each secure nobility of effect in their edifices?

(64) What detail appears in each of the Roman orders that we do not find in the Grecian?

(65) Describe the capitals of the Perpendicular Gothic period.

(66) To what class of Greek moldings does the "bird's beak" belong?

(67) What is a colonnade?

(68) How did the systems of proportion differ in Greek, Gothic, and Renaissance architecture?

(69) What are the principal examples of the Roman-Ionic order?

(70) In grouping three important elements of any design, what considerations should be given their relative sizes?

(71) What proportions should exist between the voids and solids of an elevation with arched openings?

(72) Of what two general processes does architectural composition consist?

(73) What is an *impost?*

(74) What general rules should be observed in designing a stone balustrade?

(75) In designing a tower, how should the windows be arranged regarding size?

(76) (*a*) What is supercolumniation? (*b*) What rules govern the diameters of columns in supercolumniation?

(77) What is double composition?

(78) Describe the bases of the columns during the three principal Gothic periods (Early English, Decorated, and Perpendicular).

(79) What proportions should exist between the weight and support in trabeated openings?

(80) From whom did the Romans borrow ideas in their architectural designs?

(81) How did the Romans sometimes treat the fluting of their columns?

(82) (*a*) Describe the difference between Grecian and Roman Ionic orders. (*b*) Describe the capitals of the columns in the Temple of Concord.

(83) What is a modillion?

(84) Give a general rule for the proportioning of arched openings.

(85) What prominent building in ancient Roman architecture has unfluted columns?

(86) What is *aræostyle* intercolumniation?

(87) What distinction is made in the application of the terms *composition* and *design?*

(88) With what do the Five Orders of Architecture furnish us?

ARCHITECTURAL DESIGN.

(ARTS. 1–160. SEC. 22.)

(1) (*a*) What four elements should be combined in the plan and arrangement of an office building to make it desirable to tenants? (*b*) What three elements must be combined to make such a building a profitable investment for the owner?

(2) Into what general divisions can every house plan be separated?

(3) What are the conditions to be observed in the design of an armory?

(4) What does a practical plan comprise?

(5) How many books of ordinary size can be placed in a bookcase 12 feet 6 inches long and 7 feet high?

(6) (*a*) What are the dimensions of a double bed? (*b*) How should it be placed in a room?

(7) (*a*) Name three kinds of Egyptian ornament. (*b*) Give an example of each.

(8) What considerations should be observed in locating toilet rooms in an office building?

(9) How many elevators will be required in an office building 100 feet by 100 feet, and twelve stories high?

(10) (*a*) In a building where there are fourteen offices on each floor, how many water closets will be required in the toilet room for each floor? (*b*) How many basins?

(11) What are the characteristics of the French Renaissance style?

(12) In the American colonies what strong contrast existed between the conditions of the people in the North and those in the South?

(13) (*a*) What exterior detail of a house requires the most careful study? (*b*) Why?

(14) (*a*) Where should the windows be placed in a dining room? (*b*) Where should they be located in the parlor?

(15) What characteristic of Greek ornament was continued by the Romans but abandoned by the Byzantine artists?

(16) Into what periods is the Renaissance ornament of France divided?

(17) (*a*) What peculiarities are exhibited by the gables in Elizabethan architecture? (*b*) Whence was this form derived?

(18) What specific influences developed the peculiarities of Elizabethan ornament?

(19) What is the distinguishing characteristic of the Renaissance plan as contrasted with the Gothic?

(20) What detail of middle-age architecture is still prominent in the arrangement of the plan of French mansions?

(21) (*a*) What is the smallest convenient size of a billiard room? (*b*) How should a billiard room be lighted?

(22) (*a*) In what part of the house should the kitchen be placed? (*b*) How should it be lighted? (*c*) How should it communicate with the dining room?

(23) How much room is required by each person at a dinner table?

(24) What is considered to be the best average size for an office?

(25) What three general divisions should be expressed in the elevations of a high building?

(26) What should be the first consideration in the arrangement of the plan of a bedroom?

(27) On which side of the house should the dining room be placed?

(28) What are the chief characteristics of the Elizabethan plan?

(29) How should the bathroom be located (*a*) with regard to other rooms on the same floor? (*b*) with regard to rooms on the floor below?

(30) At what speed, and how often, should the elevators run in a modern office building to give good service?

(31) Where should the stairs be placed in a modern office building?

(32) What is the elementary knowledge required to compose an appropriate church design?

(33) What is *polychromy?*

(34) What difference, in the use of sculpture, exists between Byzantine and Romanesque art?

(35) From what is the architectural ornament of the Elizabethan period derived?

(36) In what class of buildings do we find the most characteristic expression of Roman ornament?

(37) What is the essential difference to be considered in planning country and city residences?

(38) (*a*) In a small office building, how wide should the main hall be? (*b*) How wide should the upper hall be? (*c*) How wide should the stairs be?

(39) In what style of architecture are court houses, municipal buildings, capitols, etc. usually designed? Why?

(40) What style of architecture is intimately associated with educational buildings?

(41) What difference in house planning should exist between a library for family use and one for the exclusive use of a literary person?

(42) What are the characteristics of pure Byzantine ornament?

(43) Describe briefly the characteristics of Early English ornament and its modifications during the Decorated period.

(44) What American flower does the Egyptian lotus blossom resemble?

(45) What were the characteristics of the house plan in Great Britain during the period of the Classic Revival?

(46) What prominent detail existed in the exterior of the house during the Classic Revival period?

(47) What historical American residence shows the adoption of this detail?

(48) What period in European history do the conditions of the Dutch settlement in America resemble?

(49) (*a*) What is a porte cochère? (*b*) What should be its dimensions?

(50) What room in a private residence serves as a key to the sizes and proportions of the other rooms?

SPECIFICATIONS.

(ARTS. 1–28. SEC. 23.)

(1) What is a specification?

(2) For what purpose is it written?

(3) What relation does it bear to the drawings?

(4) What qualifications are necessary to enable one to write a clear, comprehensive specification?

(5) What points should be kept in mind in writing a specification, that it may be practical in every sense?

(6) Name the several general headings in a complete specification for an ordinary frame building.

(7) In what order should the several headings be placed?

(8) What general principles should be kept in mind in writing a specification, that there may be no possibility of doubt as to the meaning implied in any part of it?

(9) Name two words the use of which should be avoided, unless their meaning is fully explained.

(10) When a building is contracted for, and while the work is in progress, under what conditions would a special specification be drafted?

(11) (*a*) Why is a general-condition clause required in every specification? (*b*) Why is the wording of this clause of more importance than that of any other in the specification?

(12) (*a*) What part of the work is the general-condition clause intended to cover? (*b*) In what way does it cover the work?

(13) Name ten subheadings under the general heading of "Masonry."

(14) What is meant by *débris and rubbish?*

(15) To what depth should the joints be raked out before pointing mortar is applied?

(16) Name two items that are usually omitted from the specifications and let under a separate contract.

(17) Name four tests employed for the purpose of detecting poor workmanship in plumbing pipe lines, or defects in the pipes and fittings.

(18) (*a*) In what connection is the word *provide* used in a specification? (*b*) When should the phrase *provided and set* be employed instead?

(19) In cold climates, why should the foundation walls be carried at least 4 feet below grade?

(20) How should the stone and brick wall surfaces in the cellar be treated before whitewash is applied?

(21) In what part of the work does the specification require that metal lath be used?

(22) Why does the specification require the finished floors to be covered with felt paper?

(23) How is the plumber governed in executing work not included in or covered by the drawings and specifications?

(24) What distinctive names are given in a specification to the rough framing of a building, and the finer, or finishing, work?

(25) What disposition is made of all excavated earth, rock, etc. not required for filling in and grading?

(26) (*a*) How are the joints between lengths of gas pipe treated? (*b*) How is the pipe system prepared for testing?

(27) What provision is made for cleaning out the chimney flues in the cellar?

(28) What test is applied to the plumbing system, prior to the final acceptance of the work?

(29) To whom is the stair work of a building usually entrusted?

(30) How many ounces of lead would be required in making a joint in a 5-inch cast-iron waste pipe?

(31) Under whose direction is the glazing of the window sashes, etc. usually done?

(32) How is the veranda lamp controlled?

(33) Against what destructive agents should the electric wires and tubes throughout the building be protected?

(34) Where is Vicat cement mortar used in the construction of the walls?

(35) What work should be done on the roofs before the carpenter places any shingles in position?

(36) In what contract would the tin speaking tubes and attachments be included?

(37) Where is a steel brush employed for the purpose of cleaning stonework?

(38) In the construction of window frames, (*a*) where is Georgia pine used? (*b*) Where is oak used?

(39) At what points on the building are galvanized-iron wire baskets placed?

(40) What contractor is required to lay the mosaic floor of the bathroom?

(41) Why should the plumbing lines and fixtures be fully described in a specification?

NOTE.—In writing the following specifications, it should be borne in mind that the examples given are merely to test the student's ability to construct the phrases in a manner to include all the work required, making them as brief as possible.

(42) Specify the work and materials, including the mortar, etc., required to excavate for, and build a stone pier of rubblework below grade and faced with ashlar above?

(43) Specify the work and materials required to build an ordinary flight of stairs.

(44) Specify the work and materials required to supply a building with water from the street main, to the inside of the cellar wall.

(45) Specify the laying of a finished hard-wood floor; also, the finishing of the same, exclusive of painter's work.

(46) Specify the laying of ordinary shingles on a pitched roof.

(47) Specify the painting of a veranda with three coats of paint, including floors and natural-finished ceiling.

(48) Give a short digest for a general-condition clause suitable for a cheap country dwelling, omitting unnecessary phrases.

BUILDING SUPERINTENDENCE.

(ARTS. 1–144. SEC. 24.)

(1) (*a*) Why is it necessary to have a building superintendent over work of importance? (*b*) Under whose direction does the superintendent work?

(2) Name the important qualities of good building sand, and describe some simple tests.

(3) Who is responsible for the work of the subcontractors, the plumbers, gas-fitters, etc.?

(4) Describe some simple tests for cements.

(5) Describe two common methods of ascertaining the nature of the subsoil where an excavation is to be made.

(6) Describe briefly the construction of a carriage wash.

(7) When rock is encountered in excavating on a side hill, how may expensive excavation be avoided?

(8) (*a*) Explain the *3–4–5* rule. (*b*) How is it applied?

(9) What points must be observed in laying earthen pipes?

(10) What common practice of masons should be strictly prohibited?

(11) How should cut stone be protected during the progress of the work?

(12) Give some points which the superintendent must watch in the mixing of lime-and-cement mortar.

(13) What rules must the inspector follow in classifying lumber?

(14) How may much trouble in altering work be avoided?

(15) What attitude should the superintendent take in adjusting disputes between the owner and the contractor?

(16) What may be said about the disadvantage of having the work divided up among several contractors?

(17) Before a superintendent begins his work, what preparation should he make to become familiar with his duties?

(18) Describe a simple method of staking out a building.

(19) Describe three methods of tying stones together in the absence of mortar.

(20) Under whose responsibility is the building staked out?

(21) (*a*) What is a clerk of works? (*b*) What are the necessary qualities for a good clerk of works?

(22) Describe simple tests for determining the value of lime.

(23) What mistake must be carefully guarded against in setting the sills for cellar windows?

(24) What are the duties of a clerk of works?

(25) Under what headings should the specifications be drawn up?

(26) Describe the construction and use of batter boards.

(27) State important points to be noted in the inspection of building stone.

(28) In inspecting foundation walls, what trick, practised by dishonest masons, must be guarded against?

(29) Describe in detail the inspection of the pipes for the plumbing work.

(30) Name points to be observed in inspecting a hot-water heating system.

(31) Describe the proper joint between cast-iron and lead pipes.

(32) What requirements must be observed in hanging doors?

(33) Describe the most preferable method of temporarily heating a house during construction.

(34) Name some points to be noticed in the inspection of the gas-fitting and the electric wiring.

(35) Under whose contract is the glazing generally included?

(36) What points should be observed in examining the stock for interior trim?

(37) Describe the peppermint method of testing a plumbing system.

(38) State the qualities of good laths and their proper spacing.

(39) Describe an efficient fire-stop which should be placed between the studs of a partition.

(40) Describe the smoke test for testing the system of plumbing.

(41) Give some points to be noticed in inspecting the speaking tubes.

(42) State the details to be noticed in inspecting chimney breasts and mantels.

(43) What precaution should the superintendent take in inspecting the floor framing around chimneys, the framing of door and window openings, etc.?

(44) State points to be noticed in inspecting hardware.

(45) Give a brief summary of points to be noticed in inspecting the furring.

(46) State points to be observed in inspecting stairways.

(47) In inspecting the paint used for exterior work, what details must the superintendent notice?

(48) State some important things to be observed in inspecting the plastering.

(49) What points should the inspector notice in inspecting the rough flooring?

(50) Give some points to be observed by the superintendent in inspecting the white plaster.

(51) By what rules should the superintendent be guided in inspecting the electric work?

(52) Describe the proper method of finishing polished floors.

(53) What should the superintendent note on his last tour of inspection?

CONTRACTS AND PERMITS.

(ARTS. 1–90. SEC. 25.)

(1) Explain, in few words, the necessity of a contract.

(2) Where it is necessary to remove all or part of some existing structures, in order to build the new work, to whom do the old materials belong?

(3) Explain the difference between an entire contract and a divisible contract.

(4) To what do the signatures on a contract testify?

(5) When is the delivery of a contract deemed complete?

(6) State in what manner an architect should accept a proposal, and why such caution should be exercised.

(7) At the owner's death, on whom does the owner's responsibility for the fulfilment of the contract fall?

(8) (*a*) Name three distinct classes of contracts. (*b*) Briefly explain each.

(9) How may a contract be reinstated, which, under the terms of the agreement, has been declared forfeited?

(10) How many and what permits would be required in New York City before the erection of an apartment house?

(11) In estimating the number of bricks in a wall, what basis of calculation do the courts seem to favor?

(12) Who is generally held responsible for the safety of a building during its erection?

(13) Before a person signs any contract, what precaution should he exercise?

(14) State your opinion, based upon the information given in the text, in regard to the following: If a contract should specify that the sand taken from the premises is to be used in the masonry, and when so used is found to produce defective work, would the contractor be responsible?

(15) How should modifications be made in a sealed contract?

(16) (*a*) Is it always well to specify in a contract that the architect is the owner's agent and represents him as such? (*b*) Why?

(17) Of what value is the clause in a contract stipulating that all work shall be subject to the approval or satisfaction of the specified architect or architects?

(18) Describe fully the plans required by the New York building department before they issue a permit to commence work.

(19) Does a breach of contract entitle either party to stop the work and claim damages?

(20) May a simple contract be modified by an implied agreement?

(21) (*a*) Should an owner be entitled to damages through delay caused by the contractor not having the building completed in the stipulated time? (*b*) Why?

(22) What permits are usually required in large cities, which the architect does not obtain himself?

(23) How do the courts interpret the meaning of the phrase "more or less"?

(24) If a person signs a contract written in a language which he does not understand, will he be responsible for the fulfilment of his part of the contract?

(25) (*a*) In what light do many of the highest courts in the land look upon time forfeiture clauses in contracts? (*b*) What rule in regard to this did the Supreme Court of Michigan formulate?

(26) Does the acceptance of the work performed under a contract by the architect or owner waive all subsequent claim of existing defects?

(27) What is meant by liquidated damages?

(28) According to the stipulations of the uniform contract, to whom do the drawings and specifications belong?

(29) Upon the death of the contractor, in case there is no provision in the contract for such a contingency, who becomes responsible for the contract?

(30) What quality of materials is always implied in a contract?

(31) In the department of buildings of New York City, of whom does the Board of Examiners consist?

(32) Does the waiver of one provision in a contract invalidate the other stipulations?

(33) What caution should be exercised in making a contract with a corporation?

(34) In case the contractor should neglect to supply some important item required by the contract, would the owner, by moving in and occupying the building, necessarily, by his act, imply acceptance of the contract?

(35) If a contractor makes a proposal to execute a certain piece of work for a stated sum, and the owner accepts the proposal on the condition that the builder signs a contract, what effect does the condition imposed by the owner have on the original proposal?

(36) In what essential point does a sealed contract differ from one not under seal?

(37) What is understood by an implied contract?

(38) State the consequences likely to occur through the owner making suggestions in regard to changes from the original contract and in giving promiscuous verbal orders for extra work.

(39) What especial care should be taken in modifying a contract with a corporation?

(40) Explain why the term *not less*, as mentioned in contracts in connection with dimensions, is generally useless.

(41) What especial precaution should the owner exercise in finishing the work on a contract that has been forfeited by the original contractor?

(42) Should no stipulation exist in the contract with regard to the reservation of the privilege to reject the proposition of the lowest bidder, would the parties receiving the proposal be compelled to accept the lowest bid?

(43) What is a contract?

(44) If an architect should make out a bill of quantities to assist the builder in figuring the cost of erecting a building, is he (the architect) responsible for the accuracy of such a bill of material?

(45) If the contract should stipulate that no extra work shall be paid for unless ordered in writing, and the architect should deem it necessary for the safety of the work to order verbally such extra work as may, in an emergency, be required, would the contractor be able to recover for such work so ordered?

(46) Can a man be bound by a contract to which his assent was secured through fraud?

(47) Is the contractor usually held responsible for faulty and unsafe construction if he has carefully followed the

contract to the letter, which provides that he shall erect the building according to certain plans and specifications?

(48) If after a contract has been forfeited, it is found that there has been left upon the site, by the original contractor, a quantity of good material, consistent with the requirements of the specifications and adapted to finishing the building, what should be the owner's action in regard to such material?

(49) When there are several copies of a contract supposed to be exactly alike, but where in fact there is a difference in some detail, how does it affect the contracting parties?

(50) Of what advantage to the builder is a forfeiture or penalty clause in the contract?

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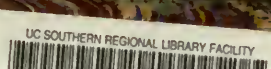

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